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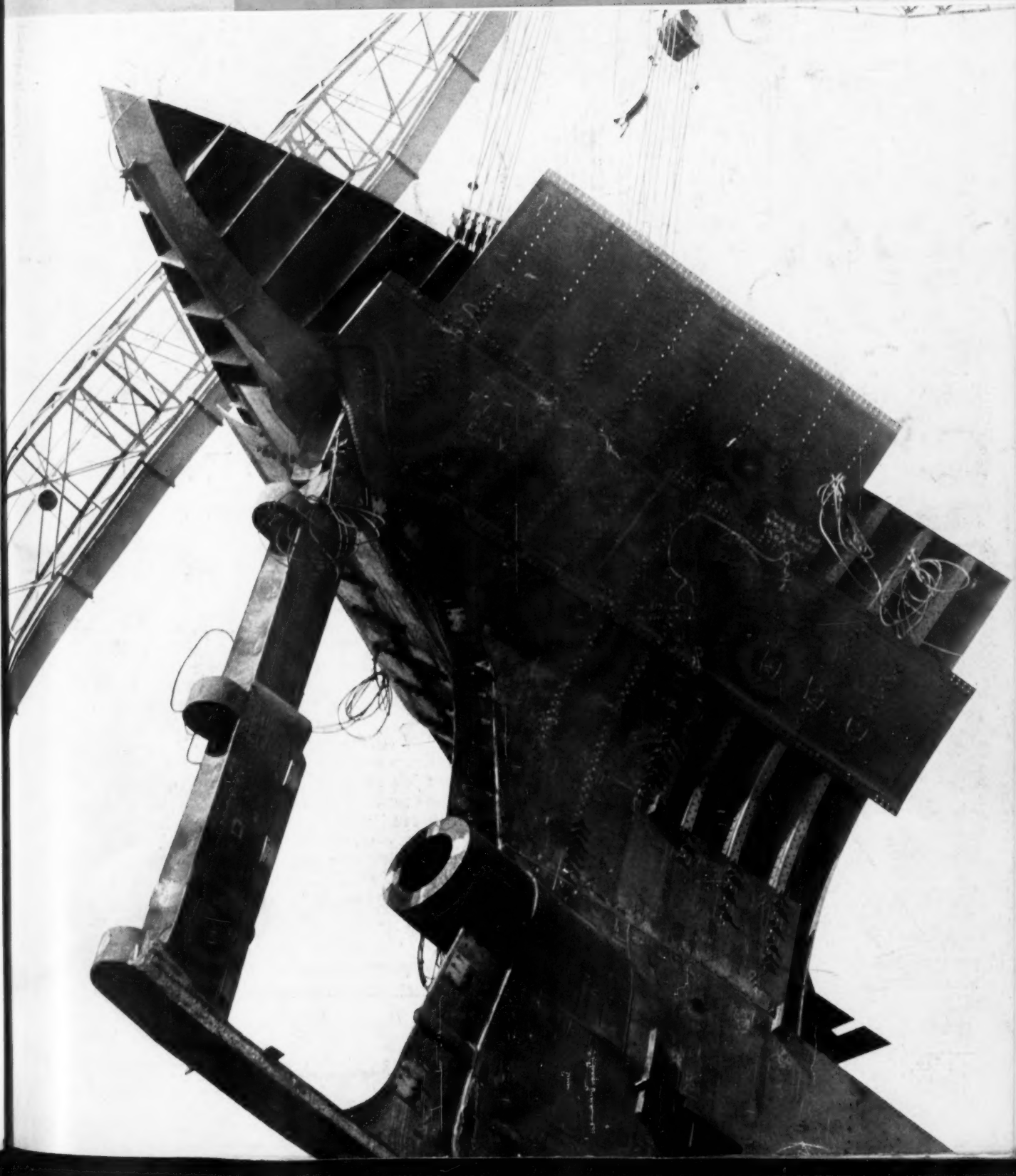
MECHANICAL ENGINEERING

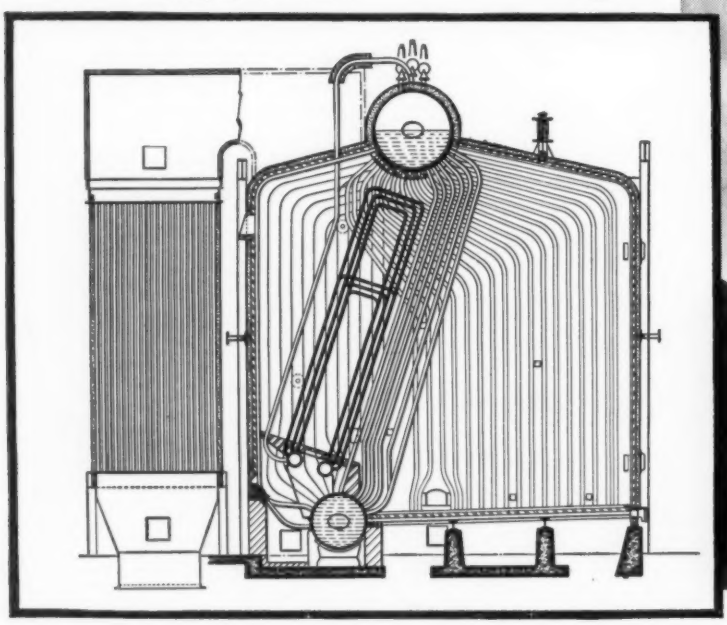
MAY 1945

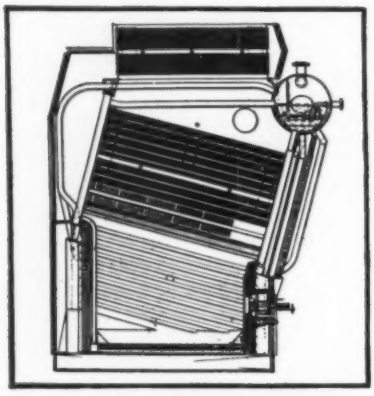


STEAM FOR FONTANA...

Installation of B&W Integral Furnace Boilers at Fontana Steel Plant.

AT KAISER COMPANY STEEL PLANT—B&W Integral Furnace Boiler—capacity 160,000 lb. steam per hr. Two units of this size and one of 105,000 lb. capacity supply superheated steam at 475 psi, 700—750 F.





. . . ON KAISER-BUILT SHIPS,

B&W Single-Pass, Header-Type Marine Boiler—a design used on many Kaiser-built ships.

. . . another job for B&W Integral Furnace Boilers

At the Kaiser Company's Fontana steel plant . . . where steel plate is produced for Kaiser-built ships . . . B&W Boilers provide all steam requirements for coke plant turbines and by-product processes, blast furnace turbo-blowers, and other mill services.

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This modern plant joins a long list of steel mills, chemical plants, refineries, ordnance and aircraft plants in which B&W Boilers have proved dependable in war production as in pre-war services.

Behind the application of these and other B&W Boilers is more than 60 years of experience which B&W engineers are always glad to share with power engineers.

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MECHANICAL ENGINEERING

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Winding Grids for Electronic Tubes

VOLUME 67
No. 5

MECHANICAL ENGINEERING

MAY
1945

GEORGE A. STETSON, *Editor*

A.S.M.E. Technical Programs

MEMBERS of The American Society of Mechanical Engineers would have been gratified and heartened if they could have been present at the meeting of representatives of the Society's program-making agencies held at headquarters on April 13 to discuss plans for the immediate future.

The purpose of the meeting over which John Sengstaken, chairman of the Committee on Professional Divisions, presided and at which some 40 persons were present, was to exchange views on how best to meet the current emergency of banned national meetings and to receive reports of papers available and in prospect. It developed that a number of agencies are already co-operating with local sections in providing papers and programs for local meetings which can be held under present conditions and that there are available for such local meetings a generous number of papers of great variety of interest and subject matter.

One formed the impression that one beneficial effect of the national-meeting ban would be the strengthening of local-section programs. This can be brought about in several ways. For example, several divisions are ready and willing to put on programs of high quality in co-operation with local sections who wish to sponsor such meetings. The meeting of the Cleveland Section in May at which the Oil and Gas Power Division will present several important papers is a case in point.

Another plan which is a customary procedure with the engineering societies in Great Britain is the presentation of the same paper in several cities. Headquarters is prepared to arrange for the scheduling of presentation of important papers before several groups. It is possible to work out a scheme whereby in a few days an author may deliver his paper before a number of audiences. With careful planning, copies of the paper can be distributed in advance so that prepared as well as extemporaneous discussion can add to the value of each presentation. Such a paper will probably be heard by more persons than if it had been delivered once at a national meeting where simultaneous sessions always reduce the size of the audience.

As explained last month, publication of papers properly reviewed and recommended for publication in accordance with established procedures will continue regardless of whether actual presentation can be arranged.

Some of the representatives of the program-making agencies reported that they had found a reluctance on the part of some authors to prepare papers for publication if these papers were not to be presented at meetings of the Society. Some of the reasons for taking this attitude are not hard to understand and it is to be admitted that certain types of papers must be presented to be of greatest value. However, technical papers of permanent value are practically useless unless published and lose little in effectiveness if they cannot be presented, provided opportunity is afforded as is planned in the present emergency, to receive discussion, prepared by those who read the paper, for publication in MECHANICAL ENGINEERING or Transactions.

Probably the greatest lift that observers experienced at the meeting of the program-making agencies was the realization that there are plenty of technical papers available for presentation and publication and that the Society has an unusual virility for meeting the needs of the present and future. Practically without exception the divisions and committees have well-planned programs under active development. They are alive to the opportunities and responsibilities that confront them. They are in close touch with what is going on in their fields and they have contacts with the engineers who are on the frontiers of progress.

Visual Aids

TRIBUTE to the progress of visual aids in classroom and shop has been long overdue. Few persons there are whose understanding of new subject matter is not aided and quickened by pictures. The interest of the indifferent is aroused and the comprehension of the diligent and intelligent student is stimulated by devices which aid in the visualization of something unfamiliar to him. Engineers in particular are unhappy when they lack pencil and paper for sketches, diagrams, and curves to embellish even their most casual conversations. Without a blackboard the average teacher loses a large part of his efficiency—unless he has the benefit of more modern visual aids.

Visual aids to instruction have been greatly stimulated by the war and the necessity of quickly training thousands of persons in subjects entirely new to them and of a technical nature. A great amount of ingenuity has been expended with excellent results as is proved by the success with which our Armed Forces have been able to utilize and keep in working order the thousands of complicated and highly technical pieces of equipment with which war is waged today. The need for rapid training to perform unaccustomed tasks and to understand principles and operations difficult to describe and in some cases impossible to see has confronted industry also. Moreover, industry employs an increasing number of principles and processes that are far from obvious to the untrained observer. Mechanical devices, made of linkages, gears, cams, and sliding members, even when intricate, are not difficult for a good mechanic to understand because he can see with his own eyes how parts are con-

nected, what actuates what, and where the trouble lies. When we get into the field of electronics, however, it is not so simple because the important things cannot be seen. Here visual aids, particularly when the animated-cartoon technique is employed, bridge a difficult gap. Many other examples might also be cited.

A number of industrial concerns have been putting out visual aids to training in these fields that have reached a high level of quality. Some are motion pictures in black and white or technicolor with sound track for description and explanation. The glamor has been left out, for they are working pictures. Where necessary the animated cartoon is used to show what the photograph cannot. Other types are recorded and illustrated lectures.

Into the making of these films and illustrations and into the writing of the scripts of descriptions and lectures a tremendous amount of thought has been expended. The result is clarity of expression and illustration, a simplicity that takes skill and knowledge to achieve, and a logical point-by-point development of ideas with correct emphasis and enough repetition to hammer home the idea.

It takes a lot of time and money to make one of these illustrated lectures. Many experts and specialists are engaged. The elimination of the confusing nonessential from text and illustration must be strictly carried out and accuracy of detail must be most carefully watched. It looks simple, but if anyone imagines it is simple, let him try his hand at writing the script or making the illustrations.

Any teacher witnessing some of the best examples of these visual aids will, if he is honest with himself, compare his own lecture and classroom techniques with these efficient, streamlined, highly developed recordings. The rambling extemporaneous explanations of the classroom, the badly drawn figures and diagrams hastily sketched on the blackboard, the illegible writing in chalk on the blackboard are mercifully short-lived. At the end of the hour the janitor cleans the board and even the echoes of the speaker's voice have died forever, or at least until another class assembles next term or next year and the performance is repeated. It is not expected that an instructor can put into every classroom demonstration even a portion of the careful planning and pruning that make the recorded lecture so satisfactory and effective. But many instructors can make use of some of the material the industries have made available and all can benefit by studying what has been accomplished with a view to improving their own teaching methods.

50 Years of X Ray

THE News Bureau of the General Electric Company reminds us that this year marks the one-hundreth anniversary of the birth of Wilhelm Roentgen and the fiftieth anniversary of the X ray.

The engineer of today does not need to be told that X-ray technique, which began as a laboratory discovery and won an honored and useful place in medicine and surgery, has become essential in many branches of industry. Without it, certain applications of welding would not be allowable; with it, flaws in the interior of steel structures can be detected. Already we can take pictures through eight inches of steel in one minute, and we are promised much greater penetration and speed with machines whose particulars are now military secrets.

Like many discoveries the X ray was subjected to ridicule and fantastic misstatement of its usefulness and application. It brought tragedy into the lives of some investigators who were ignorant of its effects on their unguarded bodies. These chapters of its history are closed and all but forgotten in the host of benefits that the years have brought in such fields as medicine, surgery, metallurgy, and engineering. Today's achievements constitute a brilliant example of the application of a discovery in science to the needs and benefits of mankind.

When the news of Roentgen's discovery reached this country, W. W. Nichols, a member of The American Society of Mechanical Engineers since 1899, was an instructor in mechanical engineering at the Sheffield Scientific School where Henry A. Bumstead was an instructor in physics. The curiosity of these two young men was fired by the announcement and they immediately placed a bunch of keys on a photographic plateholder and exposed them to the X rays. Success stimulated their imagination. A dead mouse was the next subject, and when the developed plate clearly showed the skeleton, they communicated the results of their experiments to Charles S. Hastings, professor of physics.

About this time Thomas G. Bennett, president of the Winchester Repeating Arms Company, described to Professor Hastings the case of one of his employees whose hand had been injured in an explosion of a small-cartridge loading machine. The hand had healed, but was still stiff, and the workman complained to the physician that pieces of the cartridge metal were still in his hand. Hearing this story, Professor Hastings offered to have Nichols and Bumstead take an X-ray photograph of the man's injured hand. The developed plate showed numerous small particles of metal still embedded in the flesh. These were successfully removed by the physician who used the X-ray photograph as his guide.

Seldom do we recognize the significance of historic events. The enthusiastic and impecunious instructors made arrangements to sell for one-hundred dollars to James Gordon Bennett, proprietor of the *New York Herald*, a story of the successful use of the X ray in performing a surgical operation. Academic propriety frowned on this unorthodox manner of communicating scientific facts. Gone was the hundred dollars and gone too the documentary proof of the accomplishment.

Many morals might be drawn from this experience. It is recounted here not to contribute to a controversy or priority but to remind engineers that one of their own number participated in the early history of the X ray.

A.S.M.E. Regional Conferences

Regional Conferences of Local Sections of The American Society of Mechanical Engineers are being held in May and June instead of the fall this year. The dates of the eight 1945 Conferences and the name of the city in which each is to be held will be found in the report of the A.S.M.E. Executive Committee actions, page 350 of this issue.

DIESEL-ENGINE BEARINGS

Discussion of Failures and Progressive Inspection Methods

By L. M. TICHVINSKY

VICE-PRESIDENT IN CHARGE OF ENGINEERING, AMERICAN BEARING CORPORATION, ST. LOUIS, MO., AND INDIANAPOLIS, IND. MEMBER A.S.M.E.

THE object of this report is to describe common Diesel-engine-bearing operation and failures, to set forth methods of progressive inspection of bearing failures, and to indicate rational bearing-maintenance methods.

OPERATION OF DIESEL-ENGINE BEARINGS

Maximum Diesel-engine-bearing pressures are quite high because of high cyclic loads. The operations of piston-pin, connecting-rod, and main bearings of a Diesel engine differ and depend on the type and magnitude of loading.

Piston-Pin Bearings. Maximum pressures are very high and might be of the order of 6000 psi. They are due to large peak forces in conjunction with comparatively small bearing diameters. The loading is due primarily to gas and inertia forces. Because of a swinging or rocking motion of the connection rod, the load acts over a small arc of the bearing circumference, spanning approximately ±15 deg. The lubricating-oil temperature is rather high because it is usually supplied through the main and connecting-rod bearings successively. Piston-pin surfaces are very hard, approximately 60 Rockwell C hardness at 150 kg load. Their surfaces, often chromium-plated, are very smooth, below 10 microinches. The piston-pin bearings are designed with small clearances, and successful operation depends greatly upon the damping properties of the lubricating oil.

Connecting-Rod Bearings. Maximum pressures in this case are also very high and may reach values of approximately 3000 psi. The loading of the connecting-rod bearings is due to gas, inertia, and centrifugal forces. The upper shell supports most of the load in a 2-cycle Diesel engine, while in a 4-cycle Diesel engine both the upper and the lower bearing shells carry considerable load. Connecting-rod bearings are better cooled than are main bearings as a result of the ventilation produced by the rotation of the crankpins. The lubricating oil is usually supplied from the main bearing, being forced through the oil groove and the inclined bores of the crankshaft. Crankpin surface hardness varies from 200 to approximately 350 Brinell and depends on the bearing-material hardness. The surface finish of the crankpins should be as smooth as practicable. These bearings are designed with clearance ratios varying from 0.0007 to 0.0015 in. per in. Smaller values are used in 4-cycle Diesel-engine bearings.

Main Bearings. Maximum pressures are moderate and may reach values of approximately 1500 psi. The loading of these bearings is due to gas, inertia, and centrifugal forces. The lower bearing shell is usually more highly loaded than the upper. These bearings are lubricated with cool lubricating oil direct from the heat exchanger and header. Main-journal surface hardness is the same as that of crankpins. These bearings are designed with clearance ratios varying from 0.0008 to 0.0015 in. per in.

Other Diesel-Engine Bearings. Camshaft, gear, pump, and auxiliary-machinery bearings, which operate as power bearings, are not heavily loaded and cause very little trouble when properly lubricated.

COMMON DIESEL-ENGINE-BEARING FAILURES

Failures may be caused by one or more of the following:

1 Fatigue of bearing metal under high cyclic loads.
2 Excessive or insufficient hardness of the bearing material.
3 Corrosion of the bearing metal by the lubricating oil.
4 Inadequate bond between bearing metal and bearing shell.
5 Assembly errors.
6 Foreign particles.
7 Miscellaneous, such as defective manufacture, extrusion, wiping, etc.

Fatigue Failures. Fatigue failures in heavy-duty bearings are usually produced by the cyclic peak loads and improper or loose fits of the shells in their housings. This means that a definite bearing area is pounded by the peak load every cycle, and if the physical properties of the bearing material, such as compressive strength and brittleness, are inadequate, fatigue failure may follow. Numerous small cracks, of mosaic pat-

FIG. 1 FATIGUE FAILURE

(Upper thin Satco steel-back connecting-rod bearing from a large V-type multicylinder Diesel engine after 400 hr of operation. Peak load of approximately 55,000 lb produced a pressure of 3320 psi.)

Contributed by the Oil and Gas Power Divisions and presented at a meeting of the Cleveland Section, Cleveland, Ohio, May 10, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

An illustrated talk using some of the illustrations contained in this paper was presented before the S.A.E. Baltimore Section, February 10, 1944, when the author was senior mechanical engineer, Internal-Combustion Engine Laboratory, U. S. Naval Engineering Experiment Station, Annapolis, Md. Opinions and assertions are the author's and are not to be construed as the views of the Navy Department or the Naval Service at large.

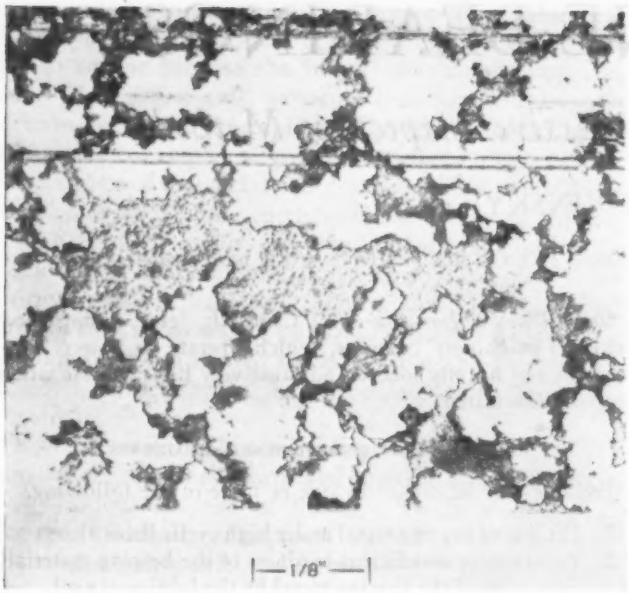


FIG. 2 FATIGUE FAILURE
(Upper trimetal connecting-rod bearing from a large V-type multicylinder Diesel engine after 400 hr of operation. Peak load of approximately 55,000 lb produced a pressure of 3320 psi.)

tern, on the bearing surface are the first indication of fatigue distress, Fig. 1. The bearing illustrated, operated under high cyclic loads at lower than rated speeds. With time, and under additional pounding, the cracks will increase in number and size. The depth of these cracks also will increase and may penetrate the entire bearing-material thickness, thus reaching the bearing shell. In such cases, some sections of the bearing material may be lifted by the high hydrostatic oil pressure, resulting in a partial loss of the bearing surface, Figs. 1 and 2. The bearing shown in Fig. 2 also operated under high cyclic loads at lower than rated speeds. Fatigue cracks which reached the bearing shell at poor bond regions are shown in Fig. 3.

Not every bearing which shows fatigue failures, such as presented in Figs. 1 and 2, should be replaced. A bearing may be replaced if fatigue failure reduced its effective bearing area by more than 10 per cent. Bearings with fatigue failures should be carefully inspected, and if it is considered that they may continue to operate, all sharp babbitt edges around the failures must be rounded by a scraper or a small electric iron in order to prevent any additional breaking off of the babbitt. Inspections of such bearings are necessary in order to ascertain that the failures are not progressing.

Hardness of Bearing Materials. The chemical specifications of several heavy-duty Diesel-engine bearing materials are given in Table 1. Bearing materials should conform closely to these specifications. The Brinell hardness of cadmium-base, cop-

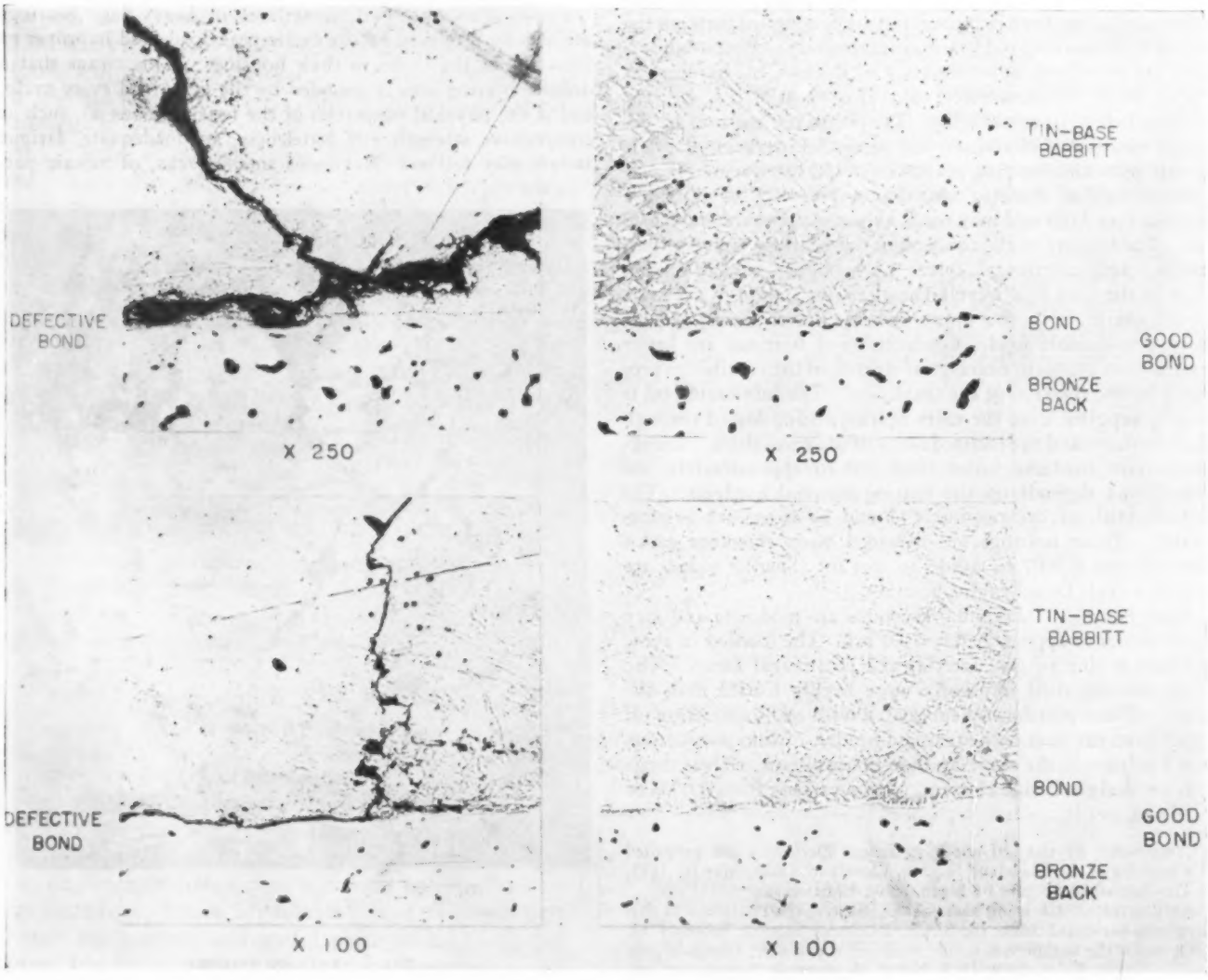


FIG. 3 BOND BETWEEN TIN-BASE BABBITT AND BRONZE SHELL
(Magnifications as reproduced are slightly below those indicated.)

per-lead, lead-base, and tin-base bearing materials is plotted against temperature, Fig. 4. Since the Brinell hardness is proportional to the compressive strength, this graph is doubly important. The region of temperatures of particular interest is between 200 and 300 F, indicated by the double lines. The cadmium-base alloys are rather hard at room temperature and rapidly lose their physical properties with increasing temperature, as indicated by the steep curve. The copper-lead mixtures retain their hardness and physical properties almost unchanged in the region of temperatures plotted. In the group of white bearing metals, comprising Satco, tin-base and lead-base babbitts, Satco possesses the highest physical properties at elevated temperatures.

The trimetal or "sandwich-type" bearing is composed of a 0.006 to 0.008-in-thick layer of tin-base or lead-base babbitt bonded to approximately 0.020-in-thick intermediate layer of bronze which in turn is bonded to a steel back.

Too hard a bearing material may score the journal surface while too soft a material may yield under the bearing pressure.

Corrosion of Bearing Alloys. Corrosion of bearing materials is due to chemical action of oxidized lubricating oils and can usually be identified by rough and pitted surfaces, such as those shown in Figs. 5 to 10, inclusive. In most cases corrosion

TABLE 1 CHEMICAL COMPOSITIONS OF BEARING MATERIALS

BEARING MATERIAL	TIN Sn	LEAD Pb	ANTIMONY Sb	COPPER Cu	CADMIUM Cd	SILVER Ag	NICKEL Ni	ARSENIC As	CALCIUM Ca	ALUMINUM Al	ZINC Zn	MAGNESIUM Mg	IRON Fe	OTHERS
CADMIUM-SILVER SAE NO. 180	0.01	0.02	-	0.50	98.0	1.00	-	-	-	-	0.02	-	-	REM.
CADMIUM-NICKEL SAE NO. 18	0.10	0.01	0.18	0.04	97.8	-	1.80	-	-	-	-	-	-	REM.
COPPER-LEAD	-	25.0	-	75.0	-	-	-	-	-	-	-	-	-	-
LEAD-BASE BABBITT NAVY GRADE NO. 6	5.00	80.0	14.0	0.50	-	-	-	0.20	-	-	-	-	-	REM.
SATCO	1.00	98.0	-	-	-	-	-	-	0.50	0.07	-	0.08	0.01	REM.
TIN-BASE BABBITT NAVY GRADE NO. 2	88.0	0.35	7.50	4.00	-	-	-	0.10	-	-	-	-	0.03	REM.

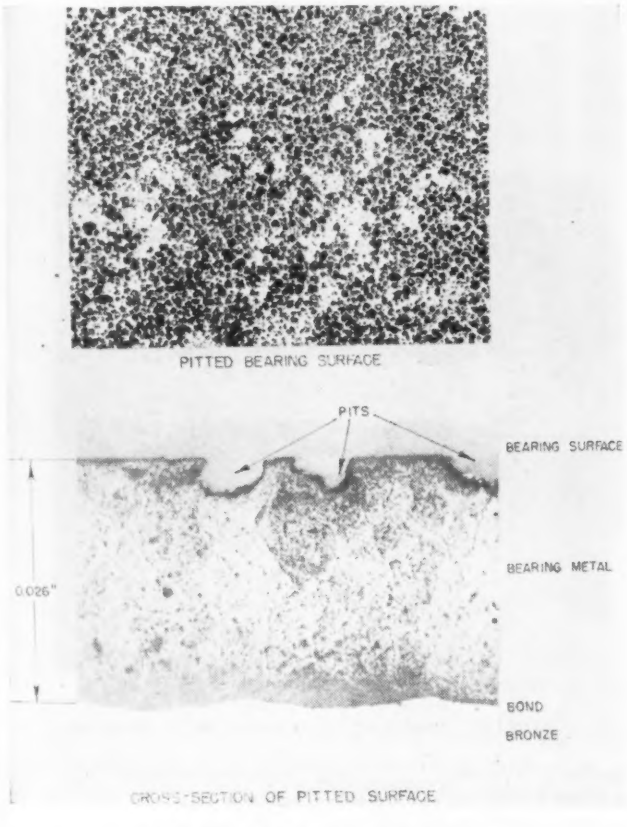


FIG. 5 PITTED BEARING SURFACE
(Upper photomicrograph approximately ×4; lower ×54.)

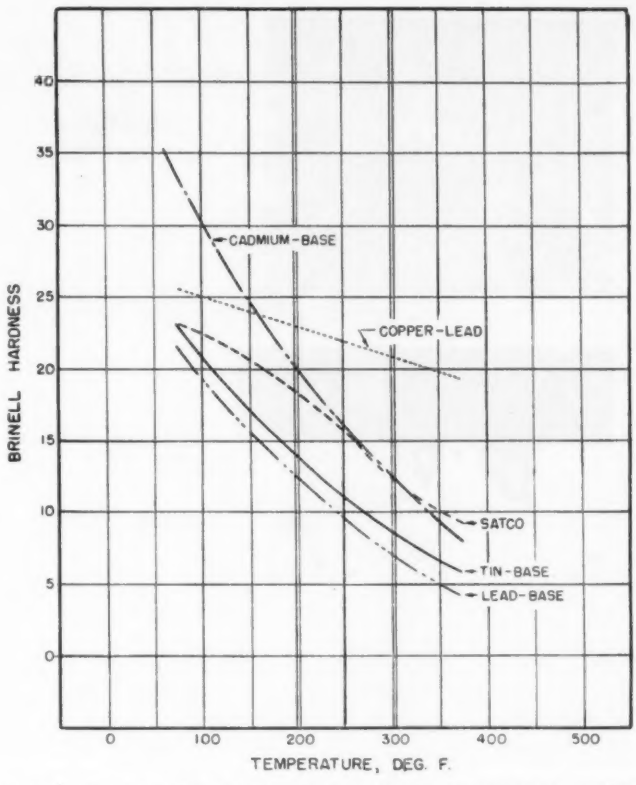


FIG. 4 HARDNESS-TEMPERATURE RELATIONS OF BEARING ALLOYS

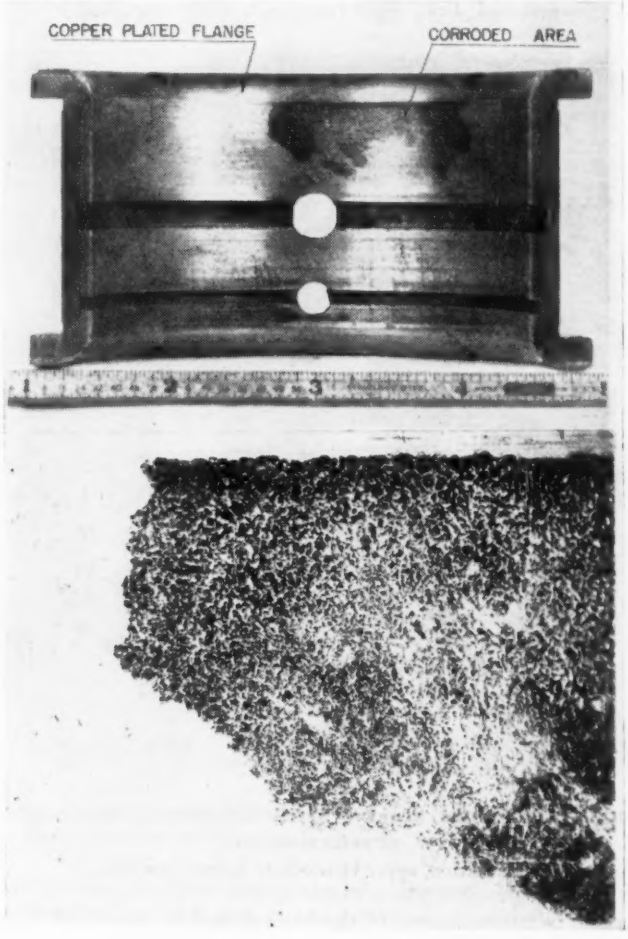


FIG. 6 CORRODED AREA OF CADMIUM-NICKEL LINING OF LOWER REAR MAIN BEARING OF A 30-KW DIESEL ENGINE
(Magnification of photomicrograph ×5.)

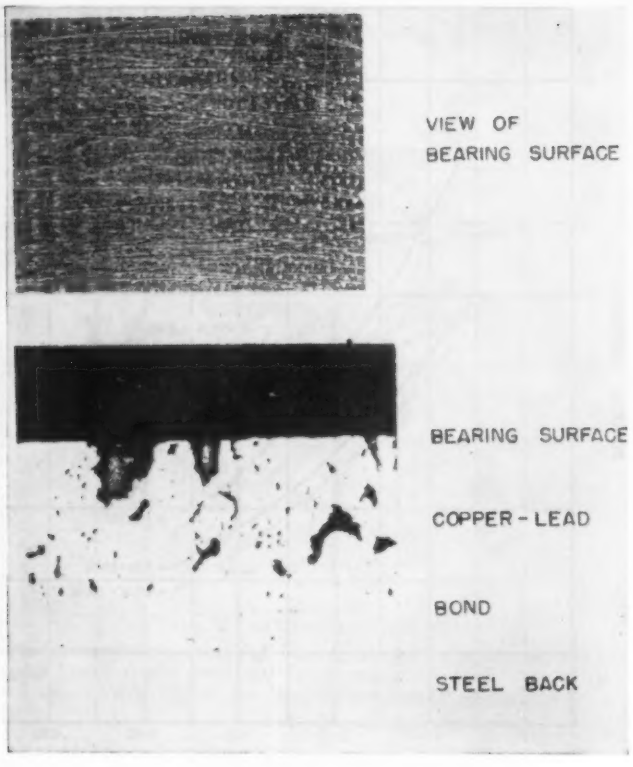


FIG. 7 COPPER-LEAD BEARING
(As received, 70 per cent copper, light, mixed at random with 30 per cent lead, dark; upper view ×4.3; lower view, ×62.)

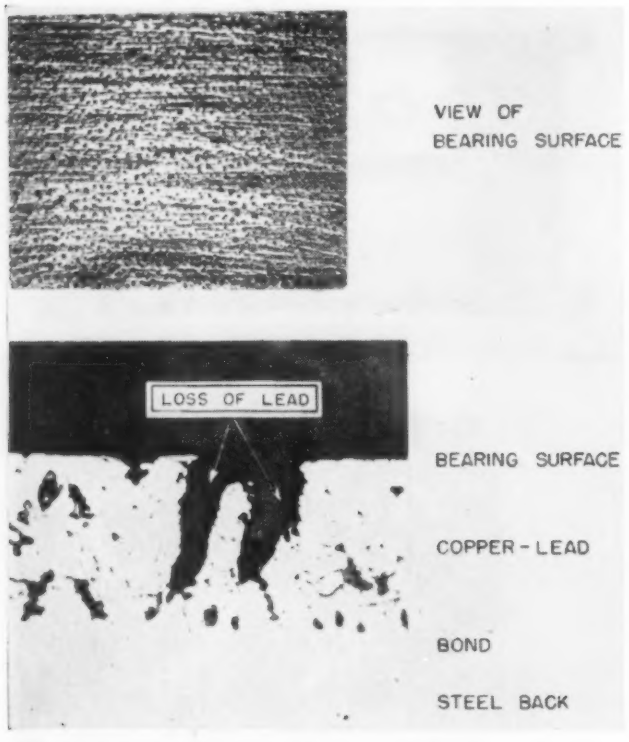


FIG. 8 COPPER-LEAD BEARING AFTER TEST WITH HIGH-CORROSIVE LUBRICATING OIL
(Magnification, upper view ×4.3; lower view ×62.)

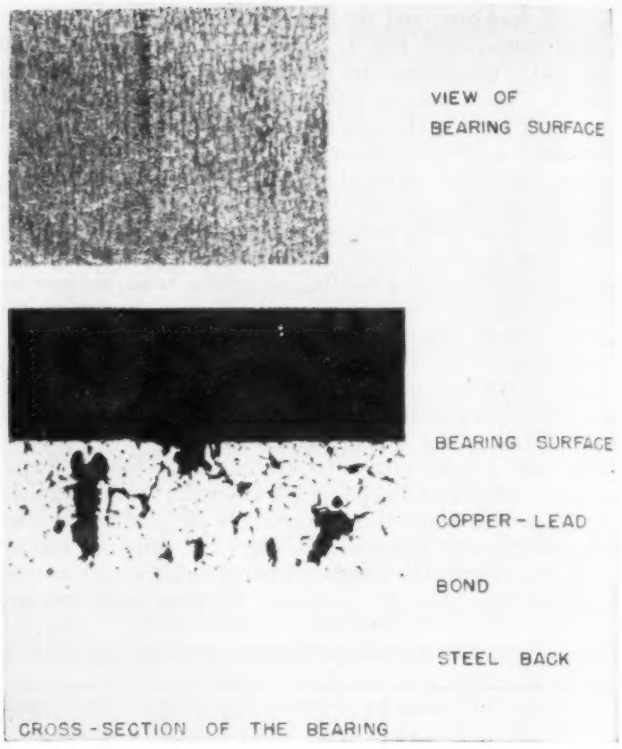


FIG. 9 COPPER-LEAD BEARING AFTER TEST WITH LOW-CORROSIVE LUBRICATING OIL
(Magnification, upper view ×4.3; lower view ×62.)

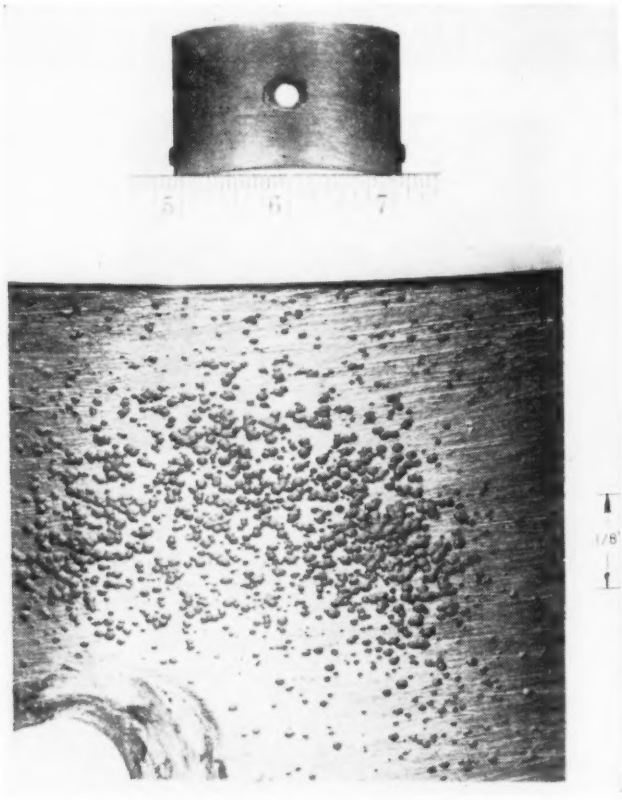


FIG. 10 CORRODED LEAD-BASE-BABBITT BEARING

occurs over small areas of the bearing and is associated with high localized temperatures.

Corrosion of Satco, such as shown in Fig. 5, occurred over approximately 50 per cent of the bearing area during the first 24 hr of operation of the bearing. It is believed that this corrosion was produced by a small amount of sulphuric acid which formed in the crankcase when sulphur trioxide from the fuel mixed with water condensate while the engine was secured. The small surface pits shown in the photomicrograph, Fig. 5, are approximately 0.004 in. deep.

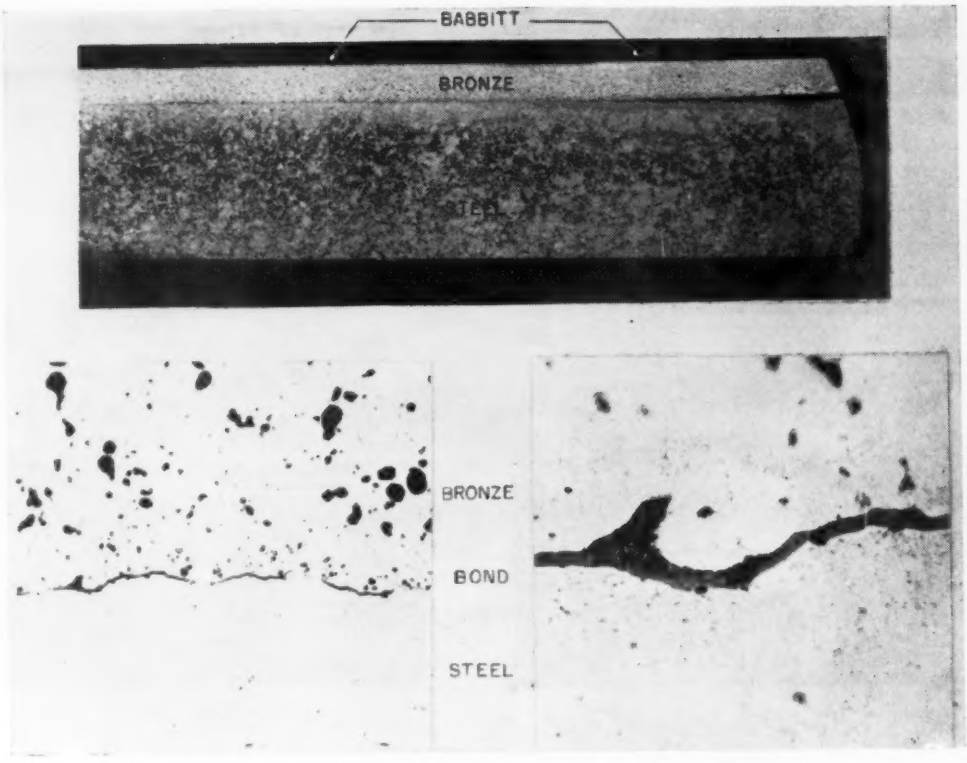


FIG. 11 DEFECTIVE BOND BETWEEN BRONZE AND STEEL OF A TRIMETAL BEARING
(Magnification, upper view ×5; lower left ×80; lower right ×360.)

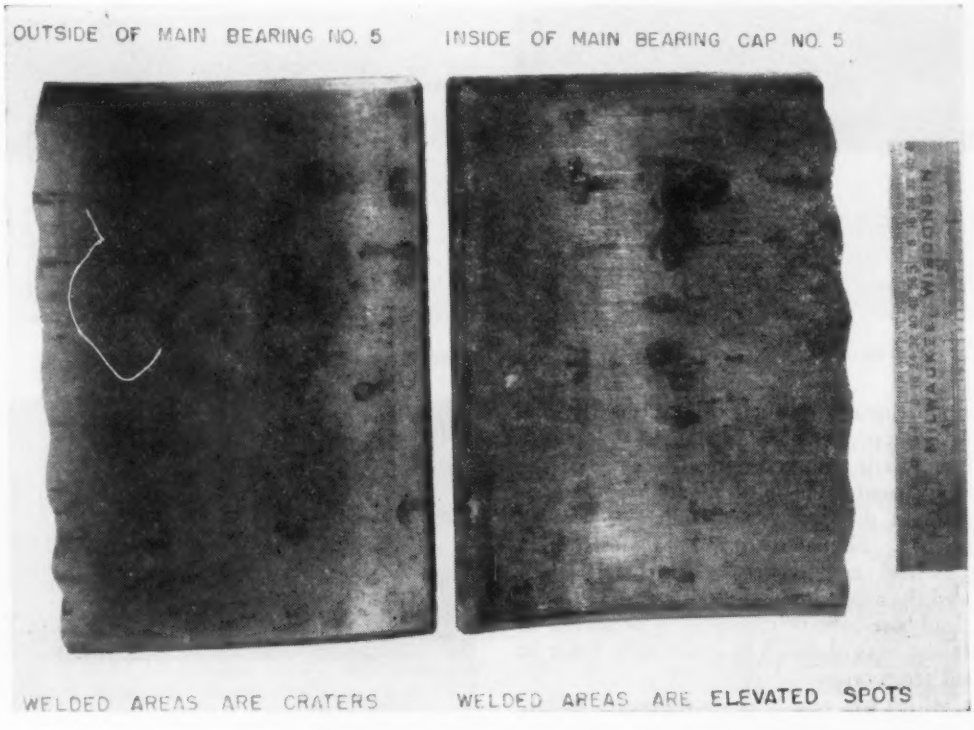


FIG. 13 LOCALIZED WELDING OF BEARING BACK TO STEEL CAP
(After separation of bearing from cap some steel from bearing back remained on inside of cap.)

Corrosion of the cadmium-nickel bearing shown in Fig. 6 was recorded during a pre-trial inspection. Since the most intense corrosion occurred next to the copper-deposited flange, it is believed that copper might have acted as a catalyst during the initial running-in period. It should be noted that this bearing was reinstalled and operated in the engine for a total of 2258 hr without any additional corrosion. It is believed that this corrosion was due to the presence of foreign matter between bearing back and housing, resulting, initially, in a local decreased bearing clearance and local temperature rise.

Corrosion of a copper-lead bearing by high-corrosive and low-corrosive lubricating oils, at 325 F, in a corrosion, tester is shown in Figs. 7, 8, and 9. The copper-lead bearing is shown, as received, in Fig. 7. The surface, top view, is enlarged 7

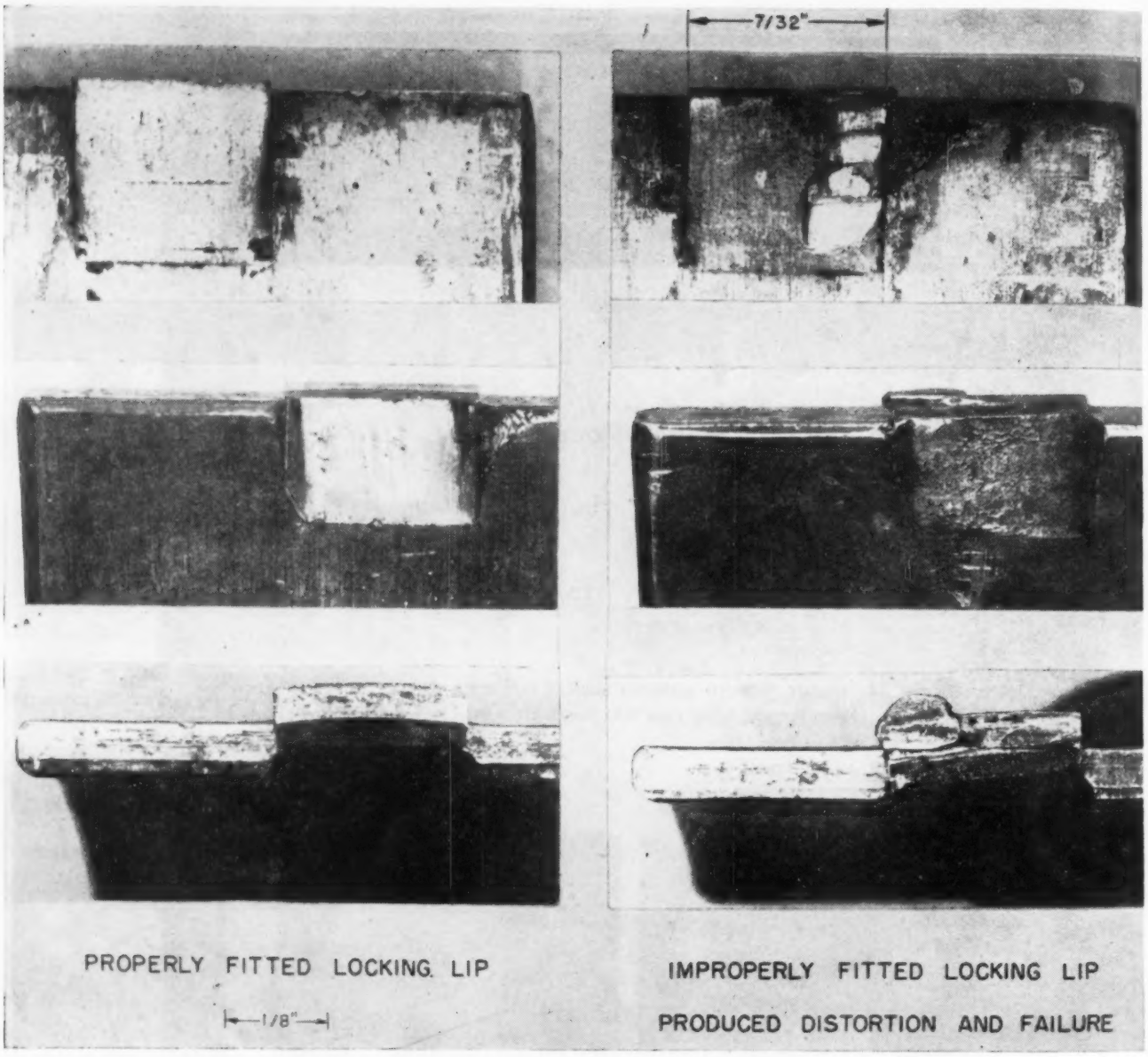


FIG. 12 FAULTY ASSEMBLY OF SMALL BEARING SHELL

times and the photomicrograph through this section, bottom view, is enlarged 100 times. The black section on this photomicrograph, above the bearing surface, is the lucite material in which the sample was mounted for polishing and photographing. The high-corrosive oil caused a considerable loss of lead, as shown in Fig. 8. Similar corrosion was observed in several small-boat Diesel engines. The low-corrosive oil only slightly corroded the copper-lead, Fig. 9.

An example of lead-base-babbitt corrosion is presented in Fig. 10; this result also was obtained in a corrosion tester at 325 F lubricating-oil temperature.

Tin-base babbitt, which has very high corrosion resistance, is usually called a noncorrosive babbitt. However, under unusual and adverse conditions it may corrode.

Because of corrosion, the bearing-load-carrying surface may be considerably decreased. This may require replacement of the bearing, especially if the effective bearing surface becomes reduced to such an extent that wiping occurs.

Bond Strength Between Bearing Lining and Shell. Poor bond between the bearing lining and the shell metal is a rather frequent cause of bearing failure and, in most cases, is due to defective manufacture. The heat flow through a poor bond area is usually impeded and may lead to failure because of uneven

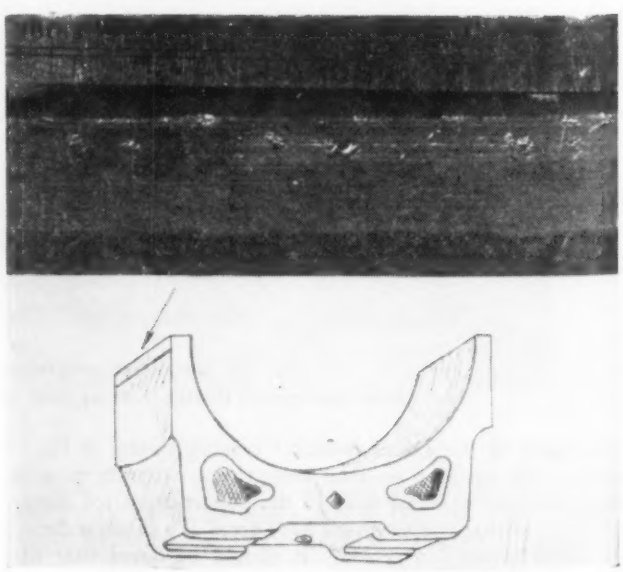


FIG. 14 LOCAL SEIZURE ON OUTSIDE CAP FIT

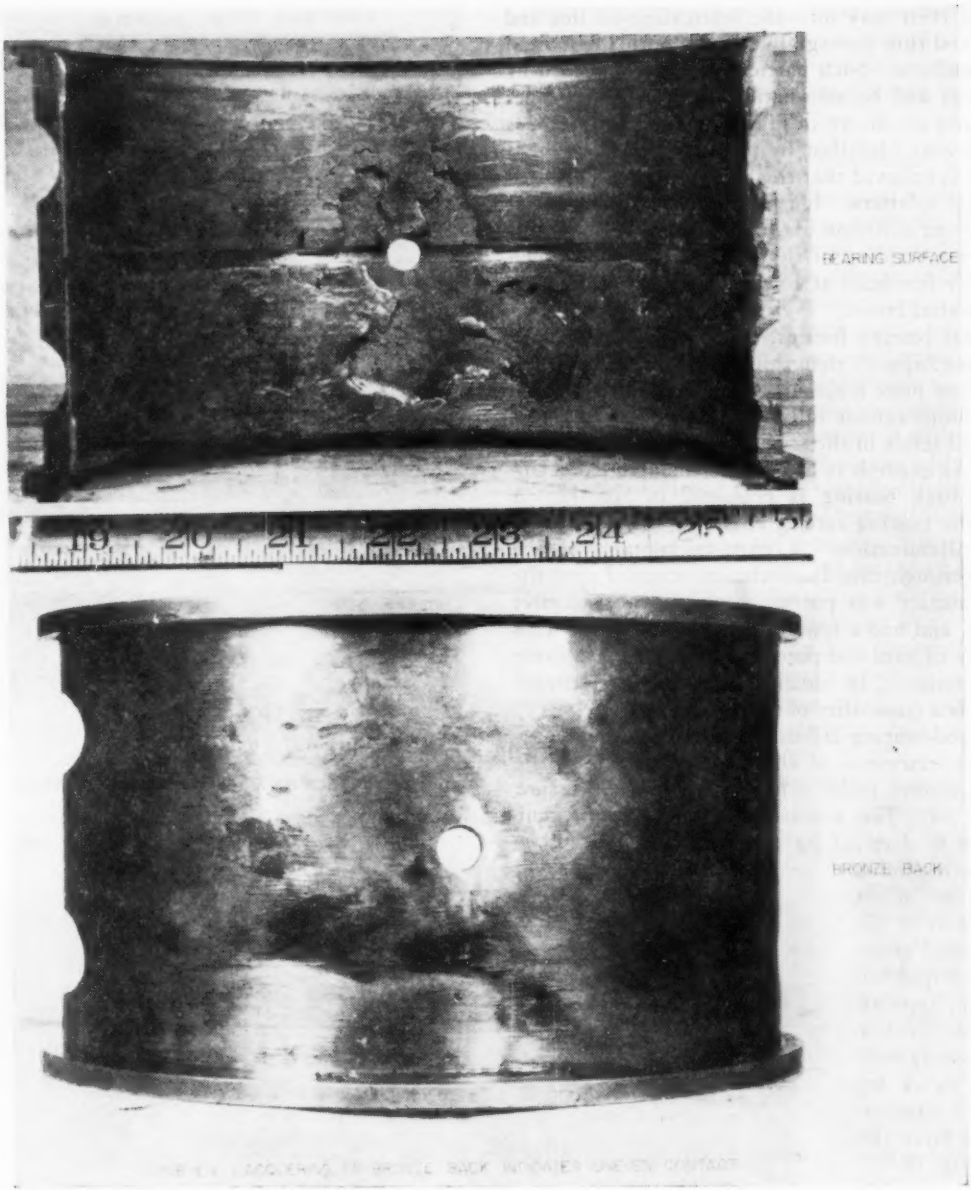


FIG. 15 BRONZE-BACK TIN-BASE BABBITT BEARING FROM A MEDIUM-SIZE DIESEL ENGINE
(Size of bearing, $6^{7}/_{8}$ in. diam × $4^{1}/_{2}$ in. long.)

and excessive bearing-surface temperature. Fatigue cracks over poor bond areas will loosen the lining quickly. Examples of good and poor bond between tin-base babbitt and bronze are presented in Figs. 3 and 11.

A sound bond between tin-base babbitt and bronze is shown in the right-hand photomicrographs, Fig. 3; there are no inclusions or foreign matter in the joint such as may be seen in black on the left where the bond is not sound. Inclusions or foreign matter in the bond are usually due to imperfect cleaning of the shell surface before applying the bonding alloy.

Poor bond in cases of trimetal or "sandwich" type bearings may occur also between the intermediate bronze layer and steel of the shell. Such a case is shown in Fig. 11. Nonmetallic inclusions between the bronze and steel will decrease the heat flow from the bronze to the steel, and local overheating may result. Such manufacturing defects cannot be detected by routine inspection and are found usually after bearing failure.

Areas of poor bond of a failed bearing are usually without any trace of bonding alloy.

Faulty Assembly. Assembly errors occur from time to time and are usually caused by negligence and lack of experience. Faulty assembly of a small bearing shell, the locking lip of which did not fit the recess in the bearing housing, produced excessive distortion which caused bearing failure, Fig. 12.

A well-known example of faulty assembly of a connecting-rod bearing is the mounting of the upper grooveless shell in the place of the lower shell which is machined with an oil groove. This results in a complete interruption of the oil flow.

Another example of faulty assembly occurred when the outside surface of the upper main-bearing shell seized to its cap, Fig. 13. This seizure, or local welding of small areas and transfer of metal, was due to working of the shell in its cap at the bearing split. This working was possible because of excessive side clearance, approximately 0.004 in., originally between the cap and the saddle. Local, minor seizure also occurred on the outside cap fit, Fig. 14.

An excessive amount of lacquer on the back of a bearing indicates a poor contact between the bearing and its cap. Poor contact may be due to excessive clearances, foreign matter, and rough finish. This usually considerably decreases the normal flow of heat and failure may occur, Fig. 15.

Failures Due to Foreign Particles. Foreign, especially hard,

particles may find their way into the lubricating-oil line and into the bearing and thus damage by scoring both the journal and the bearing surfaces. Such particles will be embedded by soft bearing linings and become harmless. Foreign particles embedded in a lining are shown in Fig. 16. The steel particles on this enclosure were identified by proper etching and by a small magnet. It is believed that the foreign particles resulted from loosened weld splatters. It is now specified that special liquids which prevent adhesion of weld splatters to the frame must be used during welding of the frame. The use of such liquids is especially beneficial at corners and narrow passages inaccessible to the steel brush.

Thin white-metal bearing linings, 0.006 to 0.010 in., have higher load-carrying capacity than thick linings, 0.015 to 0.125 in., and are therefore more frequently used than thick linings. However, thin linings cannot fully embed large foreign particles, and this will result in the scoring of the journal.

Miscellaneous. An example of defective manufacture of a tin-base-babbitt steel-back bearing is presented in Fig. 17. A discontinuity of the bearing surface could be observed under proper angle of illumination. A photomicrograph of the cross section cut through this discontinuity revealed that the babbitt near the surface was porous, contained an excessive amount of copper, and had a few rather large cavities. This small localized area of hard and porous babbitt will be a cause of initial bearing failure. In addition, because of its copper segregation, there is a possibility of scoring the shaft.

The connecting-rod-bearing failure which is shown in Fig. 18 was caused by extrusion of the bronze shell into the connecting-rod oil groove under a high cyclic peak pressure of more than 3000 psi. This extrusion was very slight, but it could be very easily detected by finger touch.

Wiping of the bearing lining usually results from slight metal-to-metal contact of elevated lining or journal areas. The surface of the wiped lining is very smooth, approximately 3 to 7 microinches. The surface roughness of a well-machined lining varies between 20 to 50 microinches. Examples of wiped Satco linings are shown in Fig. 19.

Local wiping on the top bearing of this figure is characterized by a slightly elevated polished area produced by displacement of superficial bearing lining. In such a case the bearing should be replaced.

Wiping of the rubbing surfaces of Nos. 4 and 5 Satco main bearings of a large opposed-piston Diesel engine, Fig. 19, was obtained during experimental full-load and speed operation without a running-in period. The bearing operated under a pressure of approximately 1500 psi. These bearings were also replaced.

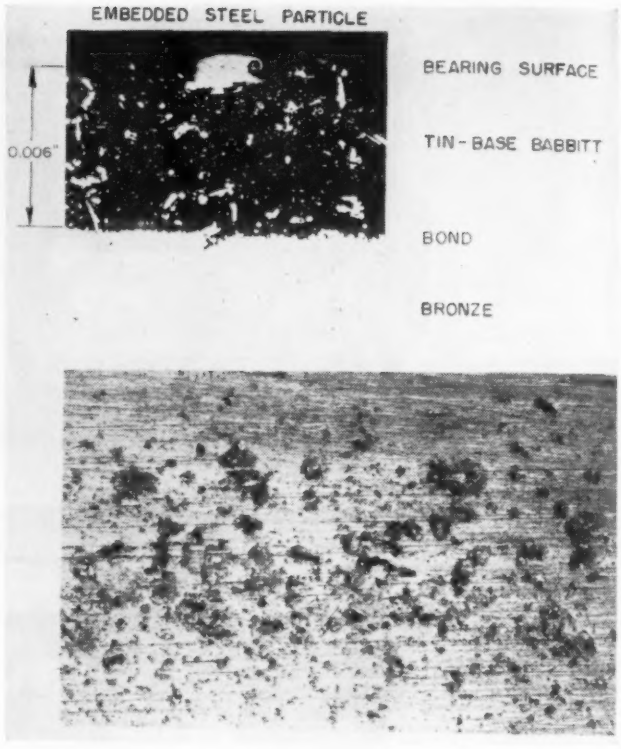


FIG. 16 SURFACE OF A TRIMETAL MAIN BEARING WITH EMBEDDED FOREIGN PARTICLES

(Magnification, lower view ×4.1.)

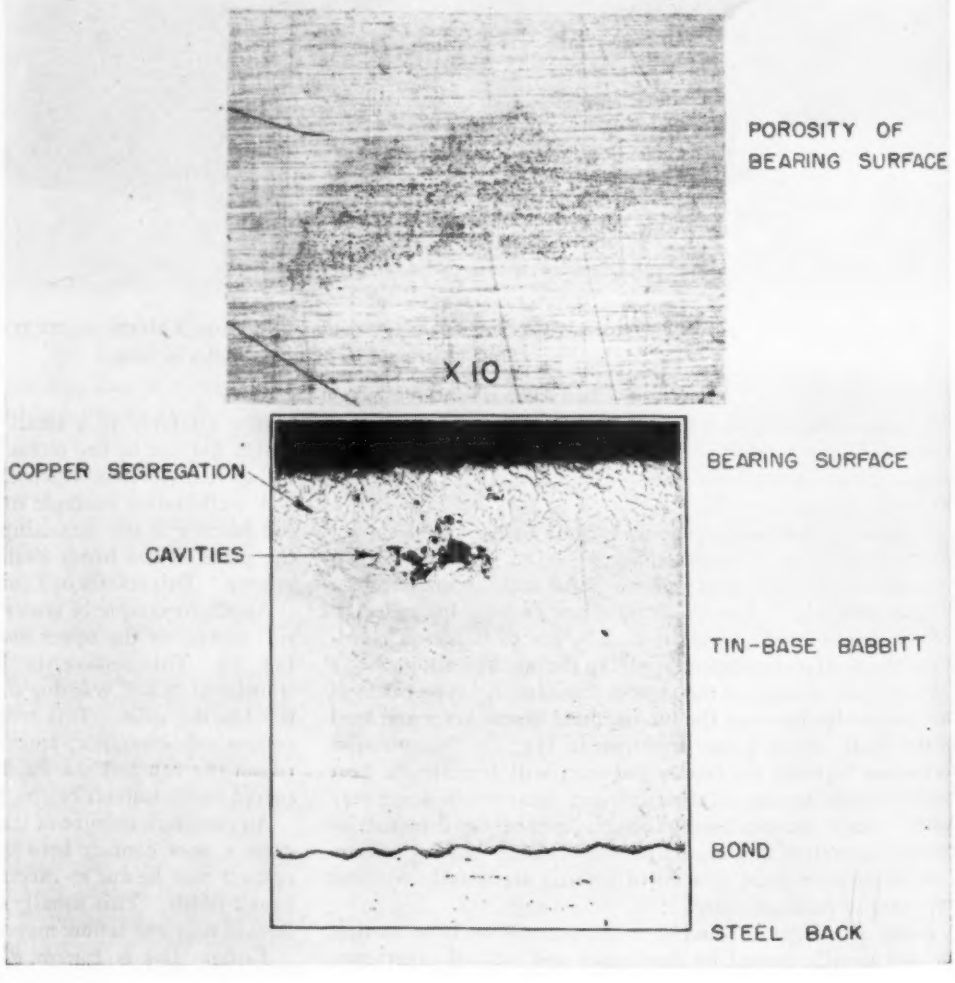


FIG. 17 DEFECTIVE MANUFACTURE OF A TIN-BASE BABBITT BEARING

(Magnification of upper view as reproduced is about ×7; lower view, approximately ×40.)

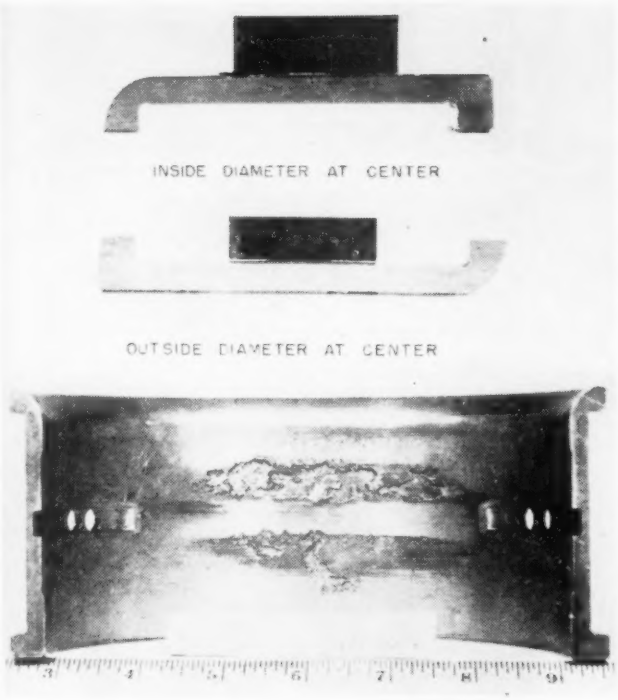


FIG. 18 FAILURE DUE TO EXTRUSION OF BRONZE BACK INTO CONNECTING-ROD OIL GROOVE UNDER A PEAK PRESSURE OF OVER 3000 PSI

Wiping not necessitating bearing replacement is very common, especially during the initial period of operation. Such wiped areas are not elevated over the bearing surface and are well-polished areas of indefinite, though oriented, shapes, as indicated in Fig. 20.

BEARING INSPECTION

Particular attention should be given to the inspection of the test-floor Diesel-engine bearings. Every periodic bearing inspection should be recorded on forms prepared for the main and connecting-rod upper and lower bearings of each test engine. Such records contain pertinent information such as date, bearing number, engine and bearing hours, lubricating oil used, and any surface irregularities such as pits, cracks, grooves, scratches, wiped and hard areas, embedded material, and others which might become useful if subsequent bearing failures occur. Such records are sometimes supplemented with photographs and, in case of observed incipient failures, with macrographs also.

A few examples of typical bearing inspections are presented in Figs. 20 to 27, inclusive. The inspection records of two experimental connecting-rod bearings, No. 6-UBE and No. 6-UBE-2, which operated for 234 and 584 hr, respectively, in a large V-type multicylinder Diesel engine from 6555:30 to 7373:45 engine-hours are presented in Figs. 20, 21, and 22.

The inspection records of a localized failure of No. A-6LT-6 Satco bronze-back main bearing which operated in a large opposed-piston Diesel engine are presented in Figs. 23, 24, and 25. These bearings operated under approximately 1500 psi pressure.

It is recommended that every bearing inspection, especially of failed bearings, be made as thorough as possible in order to facilitate the analysis of the failure and to make recommendations which will result in a decrease or total elimination of the failure. Such inspections should be made preferably with sketches of the bearing showing the locations of lost lining, cracks, pits, corrosion, and other surface irregularities and discontinuities. These sketches should be supplemented with such data as the following:

1 Engine: type, cycles, speed, firing order, etc.

2 Engine-hours: total.

3 Bearing: U., L., main, connecting rod, piston pin, thrust, etc.

4 Bearing-hours: total operation.

5 Engine operation: full load, 80 to 90 per cent, etc.

6 Bearing number and location of other failed bearings, if any.

7 Lubricating oil: type, grade, and, if possible, chemical analysis at the time of bearing failure.

8 Date.

9 Any other data which may be useful for analysis of bearing failures.

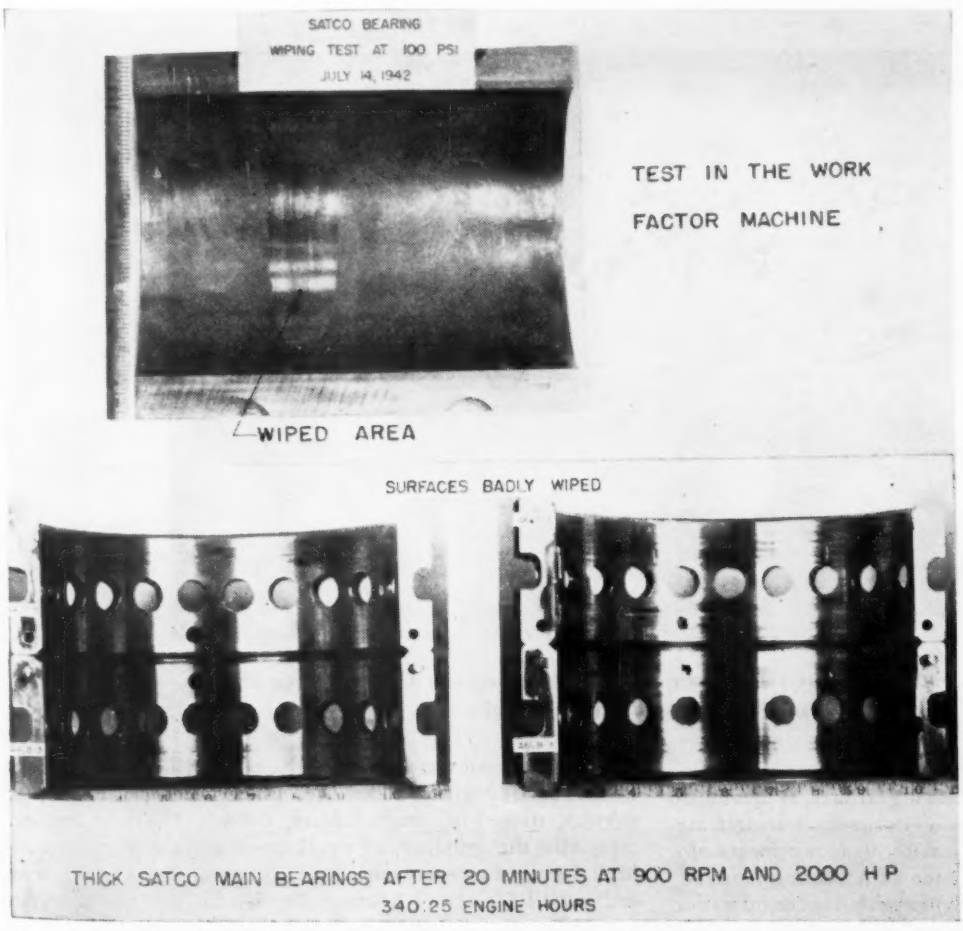

SATCO BEARING
WIPING TEST AT 100 PSI
JULY 14, 1942
TEST IN THE WORK
FACTOR MACHINE
WIPED AREA
SURFACES BADLY WIPED
THICK SATCO MAIN BEARINGS AFTER 20 MINUTES AT 900 RPM AND 2000 H P
340:25 ENGINE HOURS

FIG. 19 WIPED BEARING SURFACES
(Large opposed-piston Diesel engine.)

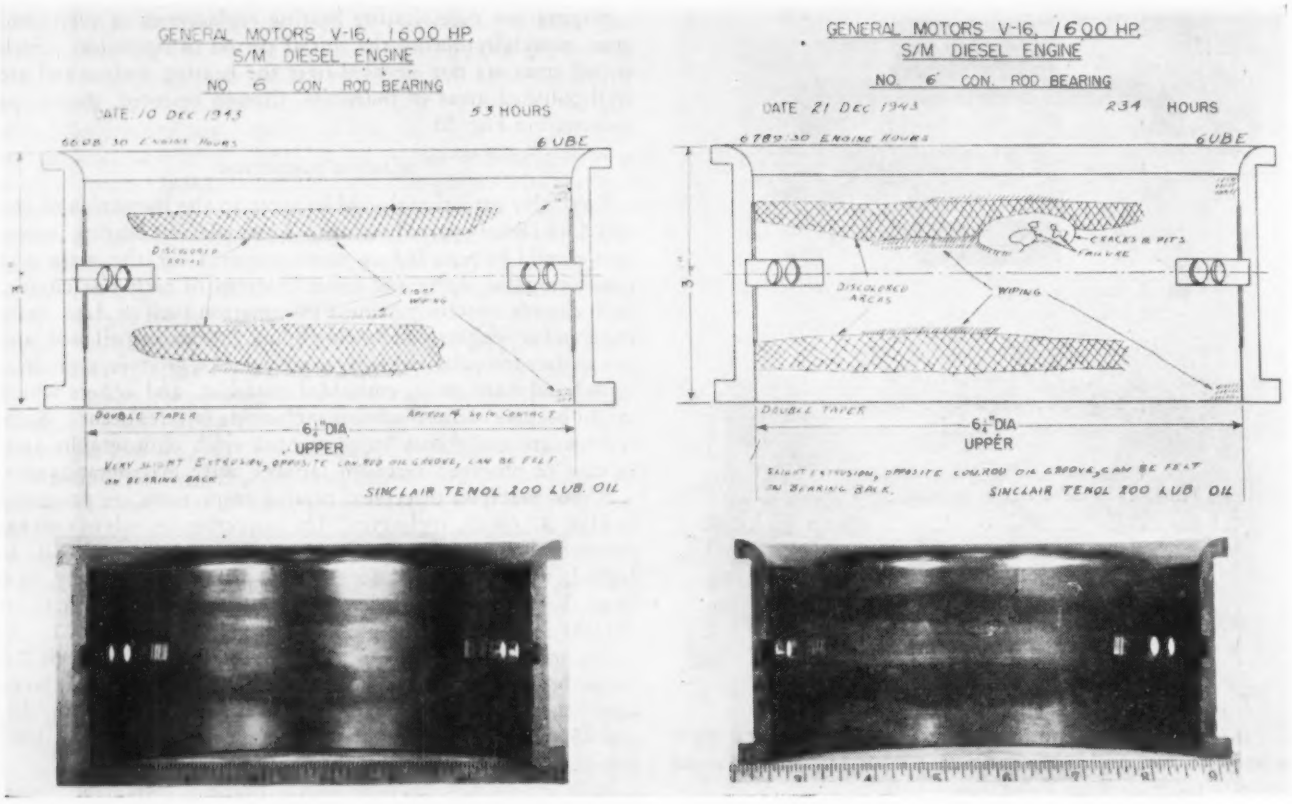


FIG. 20
(Progressive bearing inspection, thin Satco bronze-back, double tapered bearing; maximum bearing pressure: 2990 psi.)

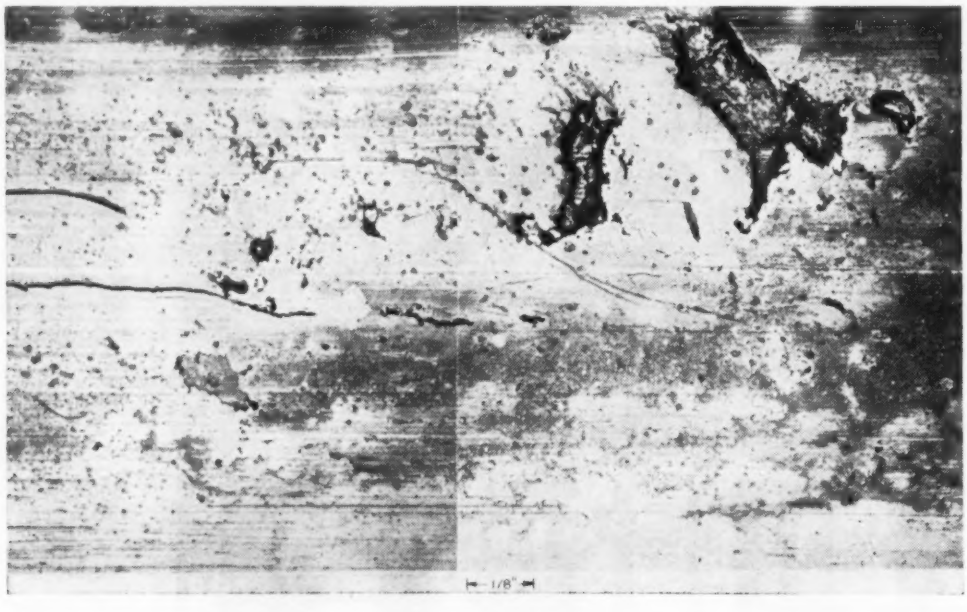


FIG. 22 MACROPHOTOGRAPH OF FAILED SECTION OF CONNECTING-ROD BEARING AFTER 584 HR
(Large V-type multicylinder Diesel engine.)

BEARING MAINTENANCE

From the discussion of common bearing failures, as previously outlined, it is evident that there is no optimum bearing material which will satisfy and comply with all requirements of a good bearing material. The selection of a bearing material, for this reason, is made by the designer with due consideration of all operating conditions, and therefore it should result in the optimum combination of lining material, journal hardness, lubricating oil, and others.

The maintenance and performance of precision-type bearings used in small engines, under 3-in. journal diam, and in large engines, over 3-in. journal diam, differ. The manufacture, especially the grinding, of small crankshafts is made with a high degree of accuracy which results in uniformity of diameter and small tolerances. Bearings for such small journals, which for uniformity are often diamond-bored, are interchangeable and do not require hand-fitting. The manufacture of a large crankshaft, on the other hand, is not as accurate, resulting in

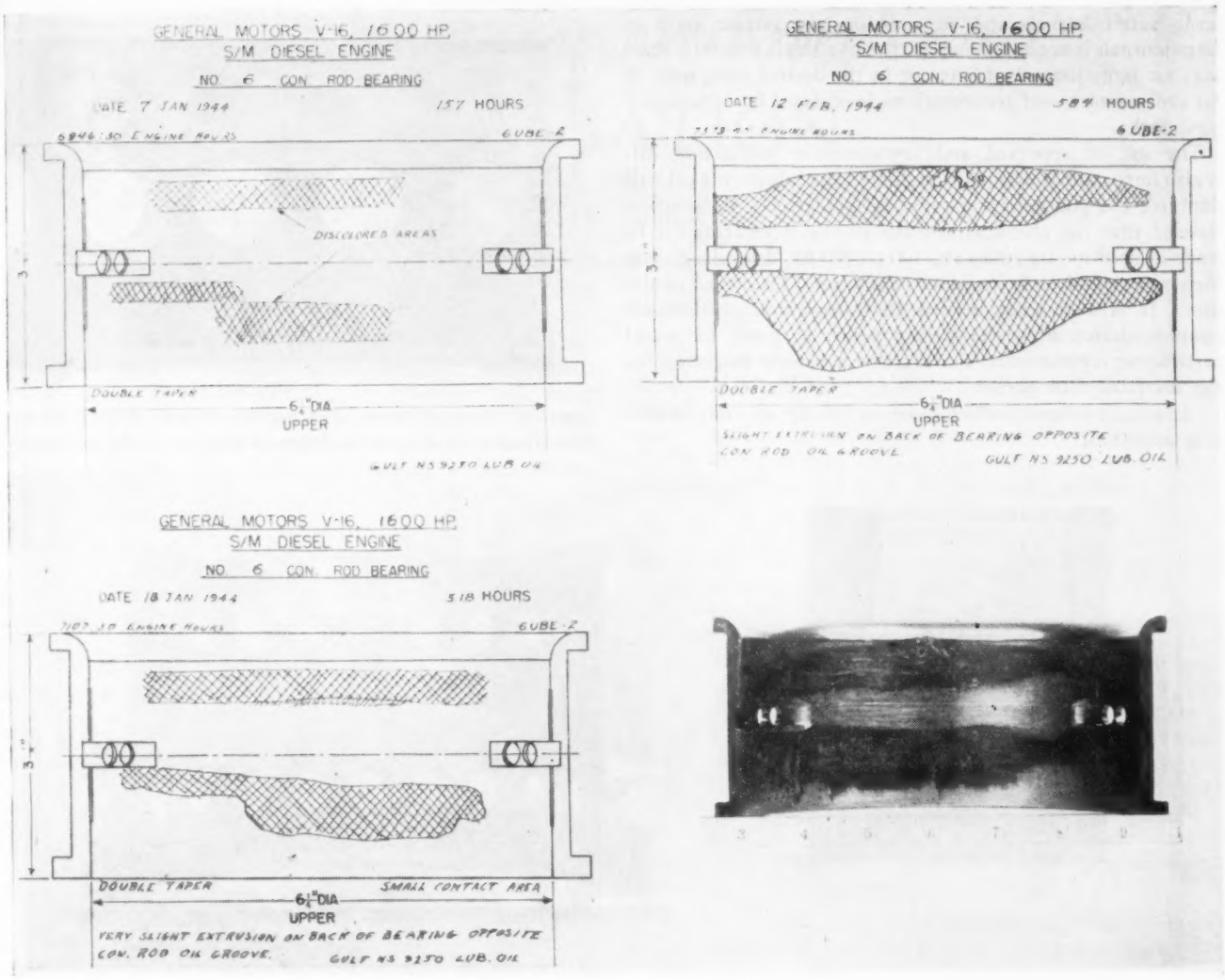


FIG. 21
(Progressive bearing inspection, thin Satco bronze-back bearing maximum bearing pressure: 2990 psi.)

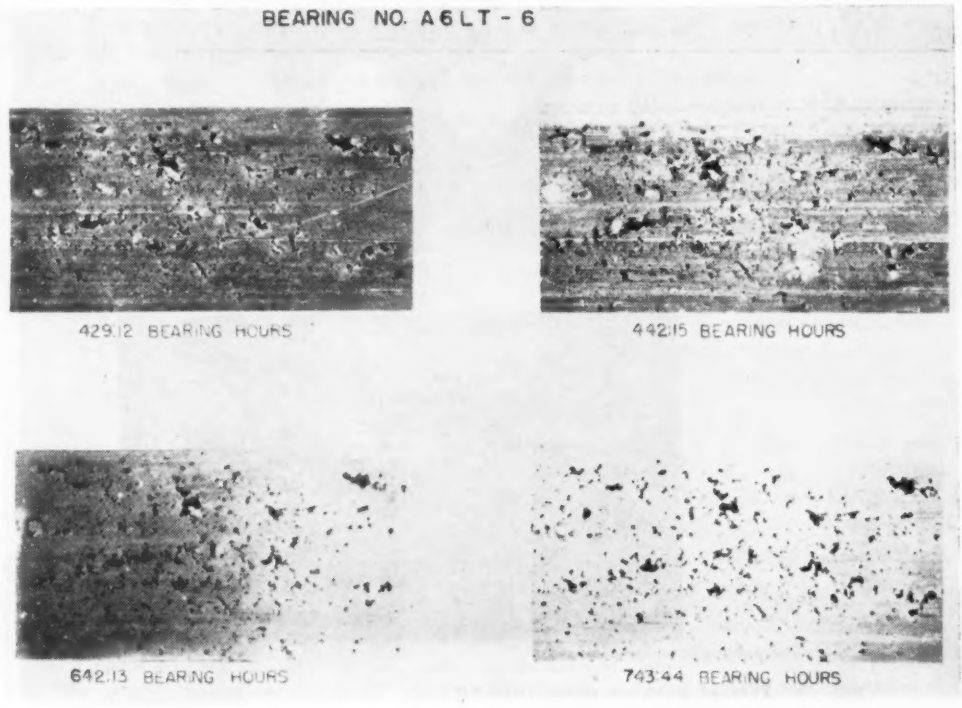


FIG. 23 PROGRESSIVE FAILURE OF THIN SATCO BRONZE-BACK MAIN BEARING
(Large opposed-piston Diesel engine. Maximum pressure approximately 1500 psi.)

large final tolerances and, in addition, the surface finish of large journals is not as smooth as that of a small journal. Bearings for large journals might not fit the desired area, over 70 per cent contact, and are sometimes hand-fitted by experienced personnel.

The use of approved and low-corrosive lubricating oils is also important. Adequate cooling of the lubricating oil will diminish the possibility of rapid oil oxidation. It is recommended that the chemical analysis of the lubricating oil be made at appropriate intervals, 100 to 500 hr, depending upon the service conditions, in order to check for dilution and oxidation. It is also recommended that inspection of sump-oil samples, drawn from the lowest point, be made for metal particles at regular intervals, together with the inspection of the sump-oil filter screen.

Cleanliness when handling bearings during assembly is also very important.

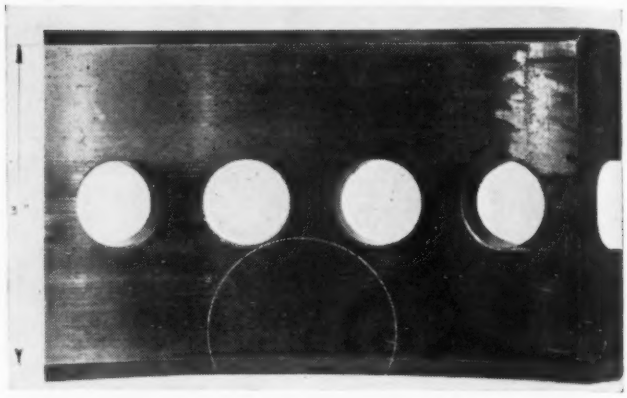


FIG. 24 BEARING OF FIG. 23 STILL SERVICEABLE AFTER 1033 HR (Pitted area, circle, examined and photographed at 429, 442, 642, 743 hr.)

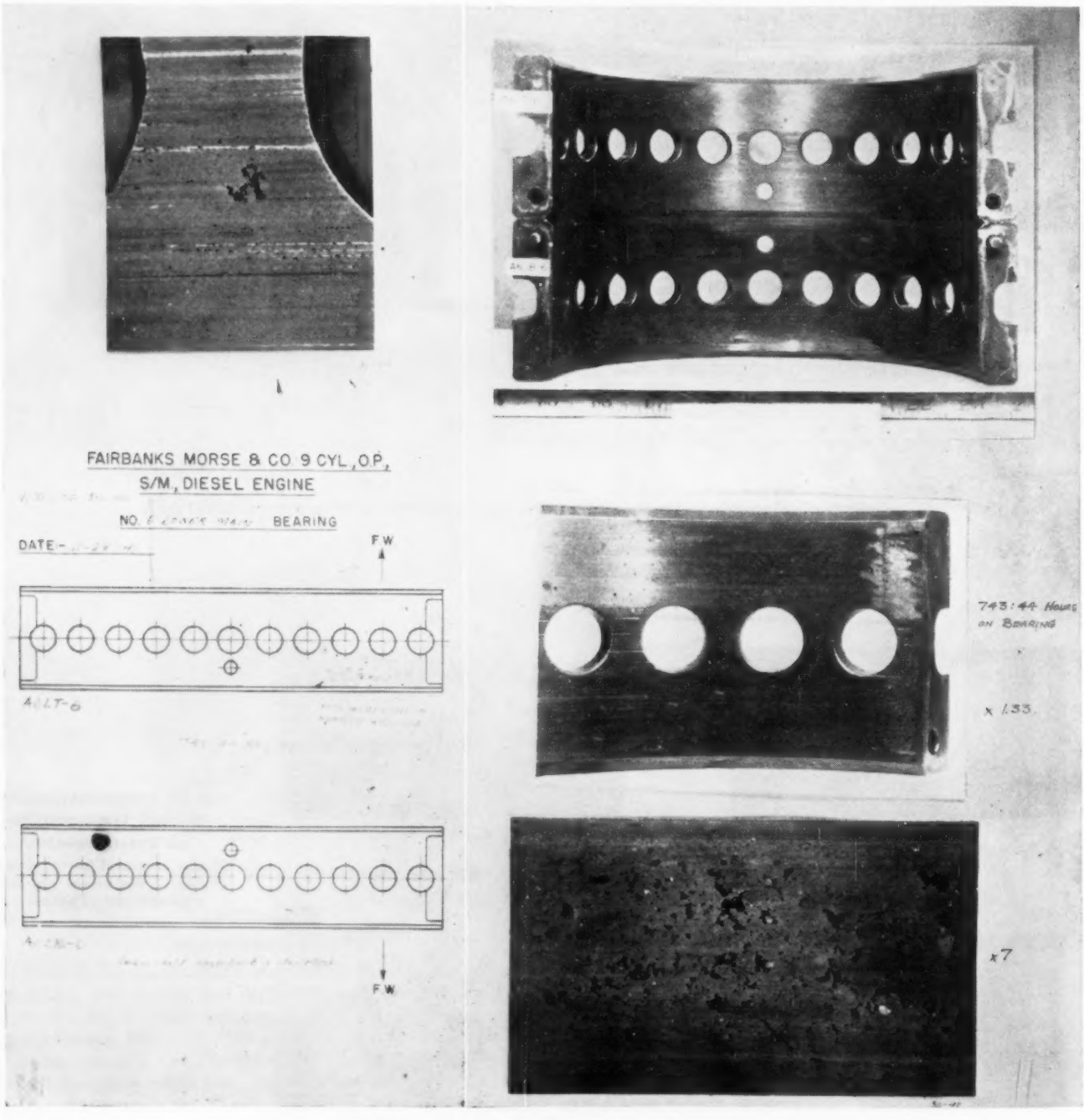


FIG. 25 TYPICAL BEARING INSPECTION RECORD

The Next Twenty-Five Years in AVIATION

By C. C. FURNAS

DIRECTOR OF RESEARCH, AIRPLANE DIVISION, CURTISS-WRIGHT CORPORATION, BUFFALO, N. Y. MEMBER A.S.M.E.

NEW ELEMENTS IN AVIATION

DURING a war very few scientists have time for leisurely contemplation or for experimentation on indefinite items; hence few scientific discoveries are made during a war period. On the other hand, developments and engineering advances proceed at a tremendous pace, particularly in applying the basic scientific knowledge that has been accumulated during the more leisurely days of peace.

During the period of the present world war, literally hundreds of significant improvements have been made in the construction and functioning of the component parts of the airplane. Very soon after the war is over these advances will begin to make themselves evident in greatly improved and, as compared to prewar years, greatly enlarged activities in commercial and private aviation. The coming era of air travel is almost certainly destined to make major changes in the pattern of American living and, in the not distant future, in the way of life all over the world.

For military reasons many of the aviation developments are on the secret or confidential list and hence cannot be discussed; but some of the important items have been publicized in general terms even though the details must still remain undisclosed. Though the list of important developments is very long, four items stand out as the ones which will probably be most effective in the improvement of aviation in the near future. These are radar, the gas turbine, the so-called jet-propulsion power plant, and the helicopter. The role of each of these will be brought into the discussion later.

COMMERCIAL AVIATION—THE FOCUS

In the immediate postwar period, commercial-aviation developments will have the greatest effect on the average citizen. Private flying will have its major effect at a later date and will be mentioned only incidentally. Probably there are three major questions that the average person would like to have answered for the commercial airplane of the future: (1) How big? (2) How fast? (3) How many? These important questions will be discussed for the immediate postwar period, up to about the year 1950, and again for the period following 1950. There are two sets of answers because, in the immediate postwar period, we will be involved in consolidating our technical gains, but after 5 years we can expect to see the really new developments becoming effective.

A recent publication by B. A. MacDonald and J. L. Drew[1] of the Airplane Division of the author's company gives answers to the foregoing questions for the year 1950. The consideration for the years beyond that must remain somewhat speculative and the answers relatively indefinite.

HOW LARGE?

Standard equipment on domestic air lines at the present time is the Douglas DC-3 which has a carrying capacity of 21 passengers. There is a current Sunday-supplement opinion that airplanes of this size are merely microscopic compared to those which will be flying in the near future, and that we may expect to see air travel in thousand-passenger planes, but reality will bring something much less dramatic than that. As far as engineering skill and knowledge are concerned, it would probably be possible to design, build, and fly an airplane weighing perhaps a million pounds and with a carrying capacity of a thousand passengers, but it is not anticipated that this will be done. There are certain practical, particularly economic, features which enter into the matter.

In order for a commercial-air-line operation to be successful and profitable, it must operate at 50 to 70 per cent capacity most of the time. Further, an air line, at least in the continental United States, must supply service with great frequency. Offhand, it may seem somewhat paradoxical, but the faster a person can travel the more does he want the service available at all times. Hence the demand will be for small airplanes flying at frequent intervals, in order to meet the public demands and still maintain a profitable operation.

It is anticipated that in the immediate postwar years the flying public of the United States will need to have airplanes of four different sizes as follows:

1 The so-called small feeder planes which will operate on side lines which lead into the main air lines and will be of 10 to 15-passenger capacity.

2 The small trunk-line airplane which will be used for local service, such as flights from New York to Chicago with several stops along the way. This will be of about 20 to 25-passenger capacity; the size of the present DC-3.

3 The bulk of the air-line travel, however, will be in passenger planes of 40 to 60-passenger capacity which will be standard equipment for the main trunk line. Two of the Army cargo planes now in widespread use are about this size, namely, the Curtiss-Wright *Commando* or C-46 and the Douglas C-54. There will probably also be a demand for a few but only a very few airplanes with a carrying capacity of 80 to 125 passengers. The new Lockheed *Constellation* which has recently been greatly publicized has a carrying capacity just a little less than this.

4 For transoceanic flights, the equipment will be larger probably starting with planes of about 100-passenger capacity and going to larger sizes as traffic increases. The Martin flying boat, the *Mars*, is a plane of about this size. Landplanes of the larger sizes will probably also be used. The Douglas DC-7 is of 100-passenger capacity.

The pattern of size for commercial aviation in the immediate postwar years is already at hand, and the typical planes are already in use by the Armed Forces. There will be a trend toward the use of larger sizes, but it will develop slowly.

HOW FAST?

In order to answer the question of how fast commercial airplanes will be, it is necessary to counter with another question: How much speed is the public willing to pay for? This

[1] "Air Transportation in the Immediate Postwar Period," by B. A. MacDonald and J. L. Drew, Report No. BR-69, March, 1944, Business Research Department, Curtiss-Wright Corporation, Airplane Division, Buffalo, N. Y.

Presented at a joint meeting of the Junior Chemical Engineers of New York and the Junior Group of the Metropolitan Section, New York, N. Y., Feb. 21, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

question can only be answered by experience which has not yet been acquired. Hence an accurate prediction cannot be made as to what the future transport speeds will be, but the trend can be outlined quite definitely.

For an airplane of a given aerodynamic efficiency, there is a most economical cruising speed. At speeds lower than this, the fixed charges, the salaries of operating personnel, etc., seriously cut down the financial return over any given period of time and thus make the operation unprofitable. At speeds greater than this optimum, more power and more fuel are required, and the general wear and tear on the equipment is greater. Speeds exceeding this optimum are bought dearly, and no one yet knows how much the public is willing to pay for the saving in time. The air-line operator would, of course, like to have his planes flying at the most economical speed, but competition and public demand may force him continuously to raise this limit.

The Douglas DC-3, the standard equipment at the present time, normally cruises at about 180 mph but that is somewhat too slow for postwar aviation. A short time ago the new Lockheed *Constellation*, aided by a good tail wind, flew nonstop from Burbank, Calif., to Washington in 6 hr and 58 min at an average speed of 329 mph. The cruising speed of this ship is of the order of 275 mph, which probably sets about the top of the anticipated commercial-air-travel cruising speed in the immediate postwar period. The moderate-sized transports mentioned before, the Curtiss-Wright *Commando* and the Douglas C-54, have cruising speeds of the order of 225 mph, hence it is anticipated that the schedules for the average commercial air lines on the moderate to long hops will be arranged for normal air cruising speed of 225 to 300 mph.

HOW MANY?

Those who expect to see the atmosphere practically saturated with thousands of commercial air liners are due for disappointment. They do not realize how much one airplane can do in the space of a year. A few statistics will clarify the situation.

The unit of measure of passenger travel is the so-called "passenger-mile." A passenger-mile is defined as one person traveling 1 mile. In the year 1940, which might be considered the last normal year in the trend of transportation, air travel amounted to 1,000,000,000 passenger-miles. In the same year Pullman travel by rail was 7,000,000,000 passenger-miles. Intercity coach travel by rail was just under 13,000,000,000 passenger-miles. Travel by bus was 11,000,000,000 passenger-miles. Since air travel amounted to $^1/_7$ of the travel by Pullman cars, both sleepers and parlor cars, it represents a substantial amount of passenger movement. Yet, in that year, 1940, there were only 338 passenger air liners used in the United States. It is a mere handful compared to the 7329 Pullman cars then in use.

In 1942, the Armed Forces requisitioned a little more than one half of the airplanes in use by commercial air lines so that from that time on the air-line business has been carried on with a total of only 165 passenger airplanes. Yet, by crowding the schedules, operating at full capacity at all times, and speeding up servicing, they were still able to maintain the level of 1,389,000,000 in 1942, and 1,632,000,000 passenger-miles in 1943.

In the careful analysis and prediction which have been made by MacDonald and Drew,[1] it is estimated that by 1950, air travel will amount to about 7,000,000,000 passenger-miles per year. That is about equivalent to the total Pullman travel in the year 1940. This will be a 700 per cent increase in a very few years, but even this will not lead to any phenomenal number of commercial airplanes.

Airplanes, of course, can carry commodities as well as passengers. It is anticipated that by 1950, first-class mail which is going further than some minimum distance, probably about 400 miles, will normally be carried by airplane. This will represent about a ninefold increase in air-mail transportation over that of 1940.

The third major category of airplane business is that of carrying cargo. Thus far, this traffic has been much smaller than air-mail traffic, and microscopic compared to the freight and express hauled by rail. In the year 1940, 3,500,000 ton-miles of cargo were carried by air. It is anticipated that by the year 1950, this air-cargo business will increase to a total of 110,000,000 ton-miles, or 31 times the 1940 cargo business.

If one takes the weight of average of all these increases in passenger, mail, and cargo traffic, the prediction is that total air business will increase approximately eightfold by the year 1950. This represents a rapid rate of increase but it still does not require any great increase in the number of airplanes. It should be remembered that the total number of commercial air liners at this time is still less than 200 and that by the year 1950, the average air liner will be twice as big as that now being used and that it will probably be 25 to 50 per cent faster. The survey mentioned indicates that all of the increased business can be handled in the year 1950, by a total of some 570 airplanes, distributed in the four categories cited. That is a long way from the tens or hundreds of thousands which many people seem to anticipate.

Private Planes. In the immediate postwar years, it is reasonable to expect that the production and use of private planes will increase substantially, but the immediate growth is not expected to be remarkable. Immediately before the war there were about 20,000 private planes in the United States which were used quite intermittently. For the most part, the private plane is still a novelty and sport item. The situation has not changed greatly during the war years. It has the same limitations it had before and is still relatively expensive. It is in about the same category as private sailing craft or motorboats. There will be definite improvements in private planes within the next few years, but there will not be enough increase in use to bring the price of a utilitarian plane down to the limitations of the average pocketbook. By the year 1950, there may be a severalfold increase in the number of private planes, but there certainly will not be "one back of every garage."

Military Planes. Trends in military aviation are almost impossible to predict. It may be in order to generalize and say that the combat airplanes will become faster and tougher, and that the bombers will grow larger, but the number which will be produced and used is entirely a matter of conjecture. It depends almost entirely upon national and international political situations, and hence can be the subject only of a guess. One investigator estimates the most probable military production as 5600 per year of all classes of planes.

GROWTH CURVES AND OPTIMISM

The foregoing, which is based on conservative and probably sound reasoning, admittedly presents a rather gloomy picture for the airplane manufacturer, perhaps even for the air-line operator, and even some disappointments for the general public. However, there is ample evidence that in any new industry there can be justification in looking beyond the conservative and sound estimates and making more favorable predictions, backed by the good old American optimism that has been proved right so many times.

The volume of every business, whether it be in transportation or in commodities of some sort, follows a characteristic growth curve. The amount of business or the number of articles in existence rises very slowly during the early years and then takes a sudden upturn and rises very rapidly. As the market becomes saturated, it begins to flatten out to a dead level. There is every reason to believe that the aviation industry is still in the low part of the curve and is just getting ready for the

rapid rise which can begin to make itself felt within a relatively few years after the war.

As a representative of an aircraft manufacturing company, the author may be accused of overoptimism, so it is probably in order to indicate those factors which might enter into the situation to justify this optimism.

FACTORS OF IMPROVEMENT

The principal commodity which the airplane has to sell is speed. It is anticipated that speed will be increased but, even if it were carried to extreme limits, the use of air travel will not increase tremendously until substantial improvement is made in several categories. These factors are the same as for any form of transportation, i.e., reliability, safety, comfort, cost, and appearance.

Reliability. One of the principal detriments to the greater use of airplanes is the unreliability of schedule. In 1941, only 91 per cent of the scheduled flights were completed, over the country as a whole. If it is absolutely essential that a person arrive at his destination on schedule, he is prone to go by rail or automobile, because of the frequency with which airplane flights are canceled.

The principal enemy of aircraft schedules is the weather. It will soon be possible to complete scheduled commercial flights no matter what the atmospheric conditions may be.

One of the outstanding developments of this war has been radar, which is an abbreviation for "radio detecting and ranging." Radar is used in many ways. Many of its applications and methods of operation are still secret, but in general it may be said that radar uses short radio waves as a substitute for light rays. This makes it possible, with proper instrumentation, to see and to make many measurements no matter what may be the condition of the weather or darkness. In all probability, radar is going to become the basis for keeping a plane automatically at a safe distance above obstacles for exact navigation at all times, for collision prevention, and for blind-approach and blind-landing systems which will be used in thick weather. There is every reason to believe that this new device plus the utilization of exhaust heat to prevent the formation of ice on the wings and fuselage will eventually make it possible to maintain a reliability of schedule at least as good as that of the railroad and with almost equal safety. If the aircraft manufacturers seriously commercialize the developments which the physicists have made during the past few years, we can expect to see a real revolution in air travel begin within the next few years.

Safety. The average person still seems to persist in thinking that the airplane is a hazardous device. For military or private planes, he is partially correct but the statistics of the situation show that the commercial air liner is safer than the private automobile. In the year 1941, there was one death for approximately 45,000,000 passenger-miles. In the same year, there was one passenger death per 36,000,000 passenger-miles in private automobiles. Hence the air liner, in terms of miles traveled, is substantially safer than the private automobile. Safety and completion of schedule are the two ends to be achieved. As the percentage of completion of schedule goes up by flying in bad weather, the safety tends to go down, but the air lines must furnish reliability and safety. They will, but it will be a severe and expensive technical struggle that will not be completed overnight.

Improvements for Comfort. At the present time, the average air trip is fairly comfortable unless rough weather is encountered, and then it can be very uncomfortable indeed. The effect of changing pressure on the ear drums in ascending or descending is also a deterring factor with many people. The latter condition can and probably will be corrected by the use of pressurized cabins. Roughness in air travel can be alleviated to an appreciable degree by using larger planes and in many cases by flying at higher altitudes. It is also probable that improvements will be forthcoming in the control systems which will smooth out the airplane's response to the bumps. A trip in rough air will never be as smooth as silk but it will be smooth enough so that air sickness will practically be a thing of the past.

Noise and vibration are major contributing causes to discomfort. The newer types of engines, to be discussed later, will almost certainly assure a quiet and vibrationless ride.

Cost. The average air trip now costs a little more than 5 cents per passenger-mile. As the amount of business increases, this figure can be brought down substantially. It is quite certain that, within a relatively few years, the cost will be between $3\frac{1}{2}$ and 4 cents per passenger-mile, and some operators believe that they can bring it down practically to the equivalent of the coach fare on railways. The dollar sign means a great deal to the average person and every small increment in the saving in cost of air travel will greatly broaden the base of probable usage.

Appearance. The modern airplane has a head start in appearance. There seems to be something fundamental about the eye appeal of the streamlined contours of airplanes. They are made that way for purely aerodynamic reasons. It is a fine example of functionalism being beautiful. Hence, it is not anticipated that major emphasis will have to be put upon the appearance factor except for the interior of the plane itself.

THE GAS TURBINE

The reciprocating engine has probably been brought to its highest state of perfection in the form of the airplane power plant. However, it has become extremely complicated and expensive and requires special fuels. Despite the fact that it is of extremely small weight per horsepower, so much power is required to send the large planes through the air that the total engine weight is a severe penalty indeed. A new and competing prime mover, the gas turbine, is now rapidly appearing as a possibility. The gas turbine is a very old device in so far as the date of conception is concerned, but until recently it has not been practical because it has been too inefficient. Recent advances in metallurgy and in certain mechanical features have now brought this device well in the forefront of the hopeful developments of the future. There is a very good chance that it will render the reciprocating engine obsolete for aircraft use in the larger sizes. Not only will it be lighter and probably more efficient, but will be very much smoother in operation than the engines now in use. This will be an important contributing factor to passenger comfort.

JET PROPULSION

Jet propulsion for military aircraft has received quite wide publicity, recently. It is a dramatic development but it is a little more prosaic than the interplanetary rockets of Buck Rogers fame. Essentially, a gas turbine is used to drive a compressor to compress air in which a liquid fuel is burned, which is then projected through a long tube. The emerging jet of expanding hot gases gives the forward propulsion to the plane without the use of propellers. It is smooth in operation but thus far the efficiency is very low at low speeds. Hence the fuel consumption is extremely high. However, at high speed it becomes more efficient than the conventional reciprocating engine and propeller combination. Hence if the speed is the prime factor, it is already a usable device. It is not unreasonable to assume that many significant improvements will be forthcoming, thus making it feasible for the higher-speed planes that may eventually be used in commercial aviation.

Some air-line operators anticipate that there will be a substantial public demand for traveling from coast to coast in the span of 5 to 6 hours. This would call for a plane with a cruising

speed between 500 and 600 mph, traveling across the country with not more than one or two stops. If the public demands this, then the industry will probably be calling for a jet-propelled plane that will fly at high altitudes. However, there will always be the demand for more prosaic travel for shorter distances at slower speeds, and this service can probably be most effectively rendered by airplanes that have the conventional propellers driven by gas turbines, with an auxiliary jet-propulsion system to make better use of the energy of the fuel and to assist in the take-off from the ground.

HELICOPTERS

The last outstanding development in aviation is the helicopter, particularly as evidenced by the work of Igor Sikorsky. As usual, it has received a great deal of irresponsible publicity which has overstated the case, but that does not belittle its real significance.

The helicopter is a new kind of aircraft. Its concept is very old but its application is quite new. It has no wings or propeller, but rather it has a large rotor turning in a horizontal plane above the fuselage which serves the purpose of both. The rotor blades themselves, usually three in number, are essentially long thin airplane wings that rotate. These whirling blades produce the lift to overcome gravity and also the horizontal thrust for forward speed. The helicopter can rise straight up out of a confined space, hover as long as desired without any forward motion, or it can move forward, sideways (either side), or backward. It can fly in almost any kind of weather and into or out of very confined spaces. It has many possible uses that the airplane can never hope to meet.

At the present time, its use has been confined largely to the Army where it is being used for rescue and observation and is undergoing intensive development. It is still a long way from perfection. It is difficult to fly and not particularly reliable. It is now at about the same level of development as the airplane of the year 1910. However, none of the problems which are still before the helicopter enthusiasts are fundamentally unsolvable. It is anticipated that its first use after the war will be for special services and for semicommercial application. It can replace the surf boats of the Coast Guard, it is ideal for crop dusting, for the control of pests in forest lands, for carrying men and equipment in and out for the fighting of forest fires, for use on cattle ranches and in oil fields. Gradually, it will evolve as a means of moderate-distance transport for commercial and private use. Although the cost is still high, it can undoubtedly be brought down greatly as more and more of them are made. It should not be thought of as a competitor either of the airplane or the automobile but as a device which will bridge the gap between the two.

PROBABLE TREND OF EXPANSION

The important developments which have been discussed can lend some substance to the feeling of optimism with which one would like to approach the new field of air transportation. The four significant items discussed will be put through the development mill first in military and then in commercial aviation. Improved materials of construction and improved methods of assembling them will bring about slow but significant advances in the reliability and weight-carrying capacity of aircraft. Improved aerodynamic designs will be forthcoming, along with new and better instruments, controls, and all the auxiliary devices that are required on an airplane. The improvements will make themselves felt first in the commercial air liners. Then they will steadily percolate down and inevitably effect improvements and cost savings in the field of private aircraft.

The average citizen would like to see the day when he could travel by commercial air lines anywhere in the world, swiftly, with certainty and safety and at low cost. That day is very close at hand. A large group of the public would also like to have highly utilitarian, safe, inexpensive, private aircraft available, that almost anyone can operate under all conditions for both business and pleasure. That is a very difficult order to fill. The public is going to have to wait a while. The advent of the helicopter brings it somewhat nearer to the realm of possibility but not even that will bring substance to all the desires.

Though small private aircraft will eventually play an important role in all our lives, it does not appear that they are going to have the extensive use or be as important as automobiles. In cost, safety, and convenience small aircraft cannot be in the same category with the automobile. They are inherently more expensive than automobiles and must be kept in top condition or they are definitely unsafe. You can lose a fender or even blow a tire on a car with relative impunity but, if you lose a wing or a helicopter rotor blade in the air, you do it only once. Hence the author does not believe that we are ever going to see a flying machine of some sort for every family. Even a helicopter cannot be landed at the curb and parked in the apartment garage.

Instead of thinking of numbers in terms of tens of millions, Americans will probably have to number their future flying machines in hundreds of thousands but even that number can be the basis for considerable optimism on the part of both the manufacturer and the user. Naturally, the aircraft manufacturer and the commercial operator think in terms of bigger and better business. When the predictions are that the operations will be small he feels gloomy. At the present time, the courage of optimism is needed, particularly for the manufacturer.

For those who say that even the substitution of airplanes for all of the railroad travel would not represent a very large business, it should be pointed out that, while the total railroad travel of the United States is about 20,000,000,000 passenger-miles per year, the private automobile travel is about 400,000,000,000 passenger-miles per year, a ratio of about 20 to 1. Tapping only a small percentage of that reservoir increases potential air travel manyfold. Moreover, Americans are far from being saturated with travel. The more they have the more they want, and they will go after it as the standard of living gradually rises. There is another factor which must not be overlooked. Despite the fact that Americans usually think almost entirely of themselves, they amount to only 6 per cent of the world's population. How rapidly the benefits of aviation spread to the other 94 per cent of the inhabitants of the earth depends in no small measure on how good a job we do in the manufacture and in the use of airplanes here at home.

AVIATION MANUFACTURING DEVELOPMENTS

By the time hostilities cease, there will have been great contractions in the present aircraft-manufacturing business. Then will begin an intense struggle for survival of the companies now in the field. It will be quite analogous to the automobile business after the boom days of the 1920's. Some of the newcomers will survive, some of the old-timers will pass out of the picture. But whatever their size or age, the survivors will have three characteristics in common. They will have competent technical staffs, imagination, and courage to adopt the newer developments with all speed. Beginning about now, the race is being run over a tough obstacle course and will continue until about 1950. There will be a great contraction in manufacturing schedules, but the ones who stay in the race will take this as an opportunity to embark on expensive and difficult development programs. They will boldly plant and cultivate the seeds of new ideas and prepare for the five-year harvest. Those who do less will be elsewhere doing other things when harvest time comes. Out of this struggle will come more, better, and less expensive aircraft which will make the latter half of the twentieth century the beginning of the real "Air Age."

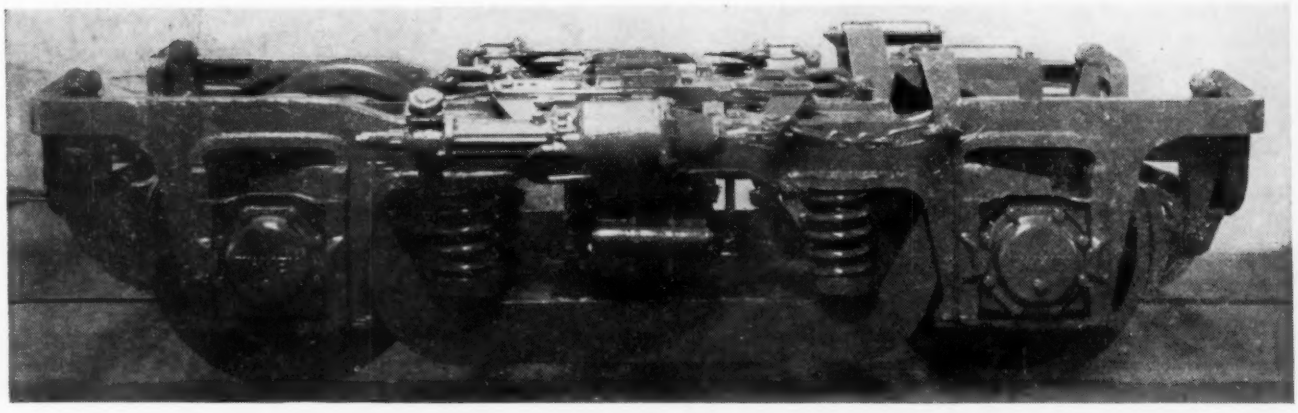


FIG. 1 TYPE OF TRUCK USED UNDER CARS OF ORIGINAL HIAWATHA STREAMLINED TRAIN

High-Speed PASSENGER-CAR TRUCKS

Studies and Developments in Design and Construction

By K. F. NYSTROM[1]

IN 1934, when the Milwaukee Road built its first streamlined *Hiawatha* train which was placed in service May 29, 1935, more attention was given to the body construction and its appointments than to the trucks. Therefore, a conventional four-wheel truck was employed which proved to be lacking in riding qualities, particularly at high speeds. The four-wheel equalized truck with helical and elliptical springs used under this equipment is shown in Fig. 1.

EXPERIMENTAL PROGRAM STARTED IN 1935

The need for an improved passenger truck was recognized, so in 1935 an experimental program was started. No satisfactory solution was immediately forthcoming with the result that the passenger cars built by the Milwaukee Road in 1936 were also equipped with conventional four-wheel trucks having minor improvements such as the use of more resilent springs, Fig. 2.

Early in the experiments it was found that personal judgment as to riding qualities could not be depended upon as conclusive test data, even from an experienced observer, so recording instruments were applied. In order to observe more closely the action of the truck at various speeds and service conditions, one vestibule step was removed and replaced with an observation booth from which slow-motion pictures could also be taken, as shown in Fig. 3. Standard coaches were used in all instances, and the final tests were made on both main line and branch lines under customary operating conditions. By conducting these tests under such conditions we were able to duplicate closely a given test, particularly as we had a traveling engineer or a representative of the test department in the locomotive cab to co-operate with the locomotive engineer as to desired speeds. While the tests were being conducted the test coach was not made available to the public as a number of instruments were in use, and the test crew was obliged to keep various records, including mileposts, location, speeds, etc.

When the truck design was believed to represent the best result that could be achieved at the time, the test coach was put in passenger service between Chicago and Minneapolis on the regular high-speed *Hiawatha* trains.

At that time opinions throughout the country were strongly divided as to a choice between four-wheel and six-wheel trucks. The four-wheel truck had been selected by the Milwaukee because of the saving in weight; others used six-wheel trucks. To obtain firsthand information we made several test runs with a coach equipped with conventional six-wheel trucks, as shown in Fig. 4. After this test was completed the center pairs of wheels were removed from the test trucks, and that portion of the load that had been carried by the two pairs of equalizers to the center pair of wheels was transferred to the outer pair of wheels by the use of a special equalizer 11 ft long extending between the outer wheels. With the exception of applying larger axles no other changes were made (see Fig. 5). Tests were duplicated with this four-wheel truck but no difference in riding qualities could be observed when compared with the six-wheel test truck. These tests also demonstrated that an 11-ft-wheel-base four-wheel truck rode no better than an 8-ft four-wheel truck already in service and previously tested. In fact the four-wheel arrangements were preferable as its noise level was slightly reduced.

DIFFICULTIES OF RAILROAD RESEARCH PROJECTS

At this point it probably would be well to mention the great difficulty one person or a single railroad has in coming to logical and correct conclusions concerning tests or researches of this kind since at best, due to other pressing duties, only intermittent time and attention can be spared. Time also is lacking to analyze test results carefully and to assure that conclusions are mature and correct. As an example, in 1915 while with the Grand Trunk Railroad in Montreal, Canada, the author developed a clasp-brake truck which was later extensively used.

[1] Chief Mechanical Officer, Chicago, Milwaukee, St. Paul and Pacific Railroad, Milwaukee, Wis. Mem. A.S.M.E.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

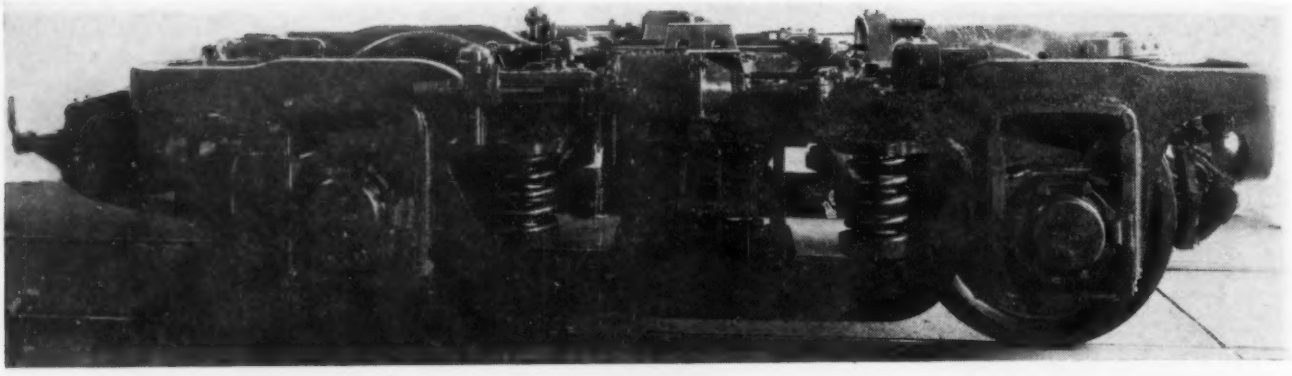


FIG. 2 PASSENGER-CAR TRUCK OF TYPE INSTALLED IN 1936, INCORPORATING MINOR IMPROVEMENTS SUCH AS USE OF MORE RESILIENT SPRINGS

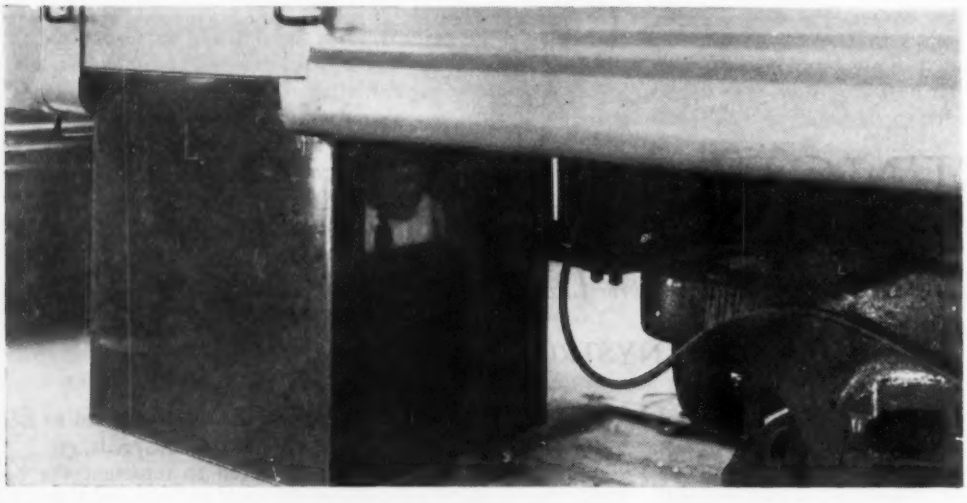


FIG. 3 OBSERVATION BOOTH INSTALLED FROM WHICH TRUCK ACTION COULD BE STUDIED

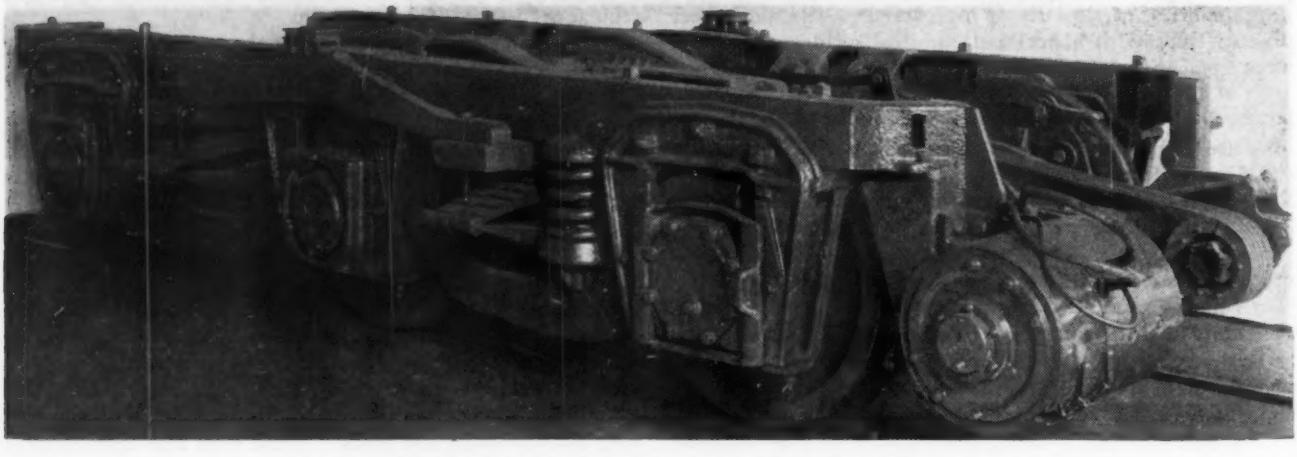


FIG. 4 TESTS WERE RUN ON THE CONVENTIONAL SIX-WHEEL TRUCK

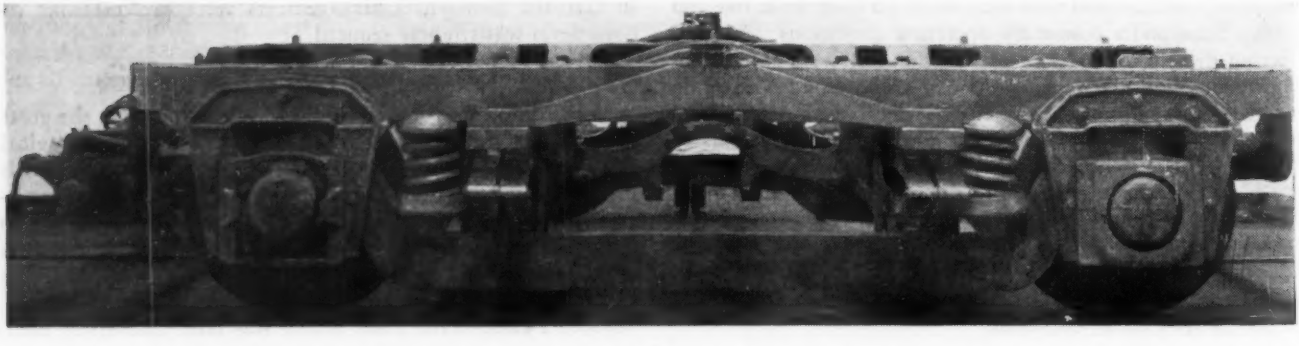


FIG. 5 SLIGHT CHANGES TRANSFORMED THE SIX-WHEEL TRUCK OF FIG. 4 INTO AN EXPERIMENTAL FOUR-WHEEL TRUCK

For the purpose of observing the action of this truck the author strapped himself to a vestibule coach step and noticed that considerable lateral motion took place in relation to the journal boxes and allied parts. The conclusion was reached that a minimum of $^3/_4$-in. lateral clearance should be provided in a journal box, or an equivalent in roller-bearing boxes, and so he proceeded to design a dual-roller-bearing box or housing providing for lateral clearances and self-aligning features.

Subsequently, on a trip to England, it was discovered that the Southern Railway had in successful service a four-wheel passenger truck wherein every effort was made to avoid lateral clearance. Although the dual-roller-bearing box is still in successful service, later roller-bearing applications have proved that lateral clearance is not essential in so far as roller-bearing applications are concerned.

With this explanation, it should be understood that any conclusion derived in this paper should not be considered as final. The only claim made is that we have definitely improved the vertical riding qualities of passenger-car trucks, as actual records will show (see Figs. 6 and 7). These charts were taken on a three-way ride recorder which shows vertical, longitudinal, and lateral acceleration. The bottom curve represents vertical acceleration and is calibrated so that each 0.1 in. on the chart is 0.1 gravity with 0.02 initial tension. As both charts were taken with the same instrument and the same calibration, the merits of this or other types of accelerometers will not be discussed. However, we are not satisfied with our accomplishments for we know there is room for further improvement.

VARIOUS SPRING COMBINATIONS TESTED

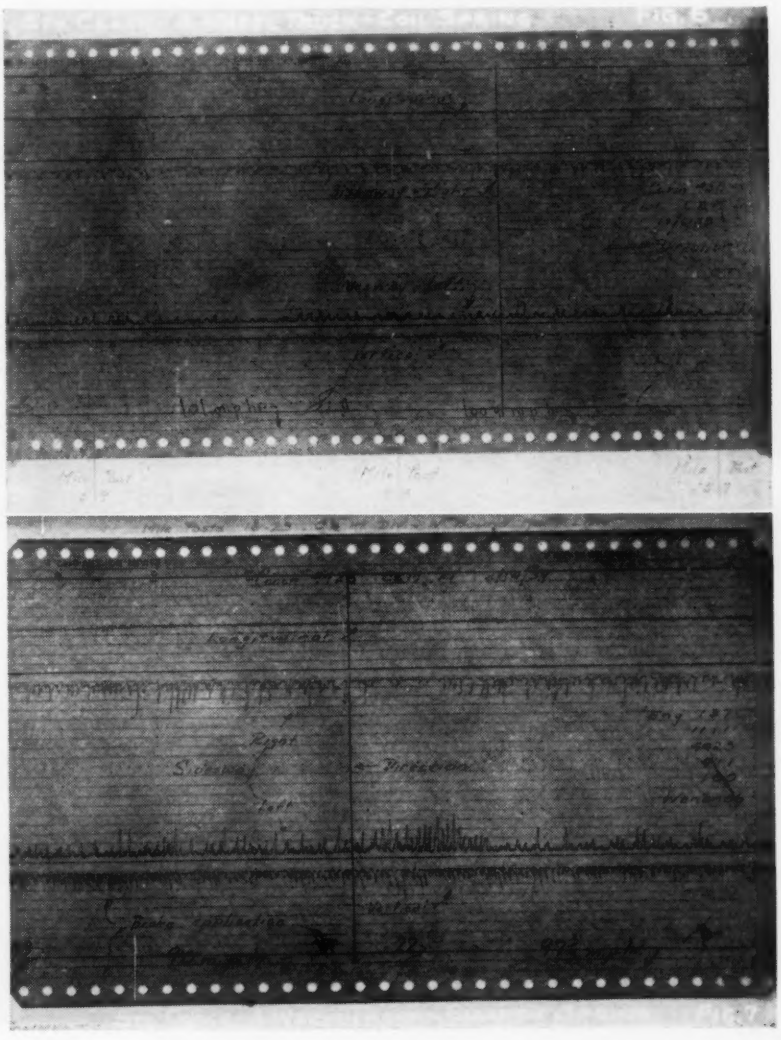
A large number of tests were made with various spring combinations, and in 1936 a truck was designed somewhat similar to the European type, as shown in Fig. 8. The bolster was supported solidly on a swing-hanger axle without springs, there being no springs between the swing-hanger axle and the truck bolster, the swing hangers themselves being pin-connected to a spring-supported auxiliary bolster. The major portion of the springing of the truck was concentrated around the journal box. This type of construction later came to be known as a triple-bolster truck. The spring deflection had to be held so low under the swing hangers to maintain car-body stability that it was abandoned as a high-speed truck although this truck is still in service under a suburban car.

When our own initiative failed as far as adopting European truck practice was concerned, we obtained drawings and duplicated a truck generally used in Europe, known as the Gorlitz truck, which differed from the truck shown in Fig. 8, in that the triple-bolster feature was eliminated and a single bolster employed, supported by semielliptic springs suspended by hangers from two wheel pieces. This truck is shown in Fig. 9. Extensive tests were made with this truck but it did not possess sufficient merit to warrant its adoption for high-speed service; however, it is at the present time operating under a coach in suburban service.

Experiments were continued, working on the premise that a truck having the springs applied over or immediately at the journal box would be more desirable from a cost and weight standpoint. Extensive tests were therefore made with the truck shown in Fig. 10, which was a nonequalized truck using a single nest of coil springs over the journal box. This truck was designed so that if the nonequalized feature was unsatisfactory an equalizer could be applied. At this time in our test program several novel features were introduced, i.e., the conventional elliptical bolster springs were replaced with large-diameter coil springs, vertical shock absorbers were introduced, and levelizing bars employed. This experimental truck possessed many desirable features but at speeds over 90 mph it produced considerable vertical oscillation and therefore was unsatisfactory.

The same truck, with the elimination of the helical springs over the journal boxes and the introduction of an equalizer with conventional equalizing springs, was employed under passenger cars built at the Milwaukee shops in 1938, and is shown in Fig. 11. This truck proved to be very satisfactory with the exception that the conventional wear of roller-bearing boxes, equalizers, spring hangers etc., still persisted.

In 1939 an inboard truck was developed, equipped with a rotor brake. The generator for air conditioning and train lighting was suspended from the truck frame and driven by a pneumatic rubber tire held against the tread of the wheel, Fig. 12. While this truck was very desirable from a weight standpoint and had good lateral stability due to the increased spread of the bolster springs, it also had some weaknesses. The brake at that time was not sufficiently developed to justify its application, the roller-bearing arrangement being cumbersome and inaccessible, and most of the parts were not interchangeable with existing trucks. The generator drive, though interesting, was not very successful.



FIGS. 6 AND 7 CHARTS SHOWING CURVES MADE BY THREE-WAY RIDE RECORDER

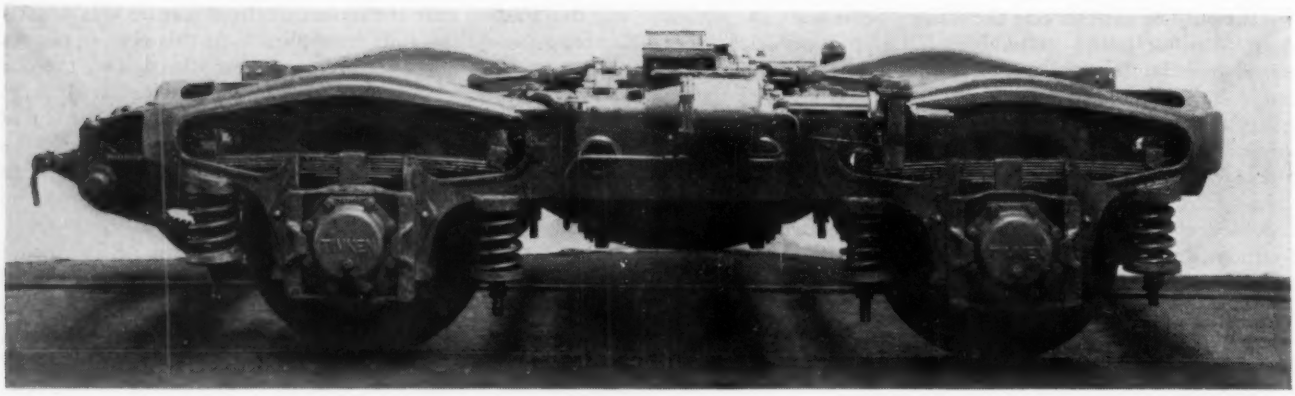


FIG. 8 DESIGN ADAPTED FROM EUROPEAN TRUCK PRACTICE

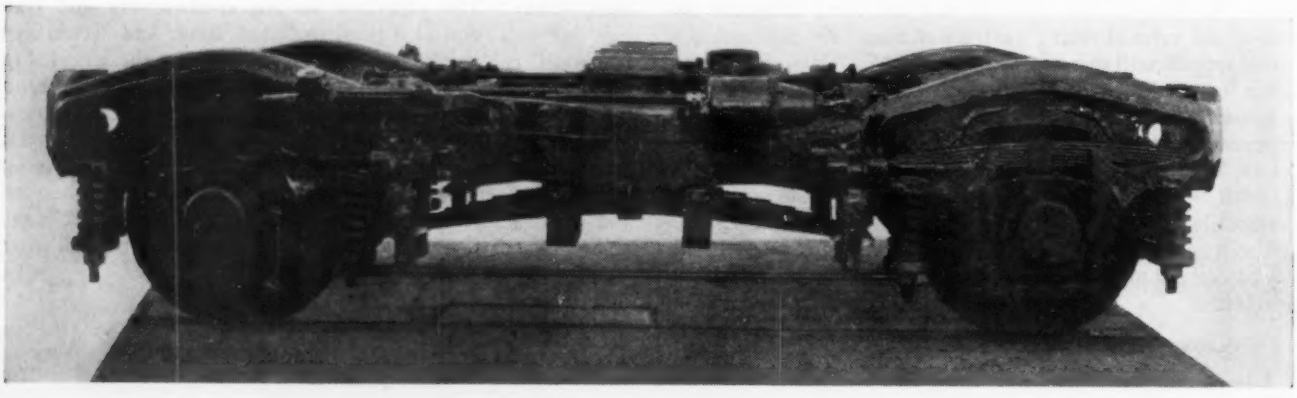


FIG. 9 EUROPEAN-TYPE TRUCK WITH SINGLE BOLSTER SUPPORTED BY SEMIELLIPTIC SPRINGS

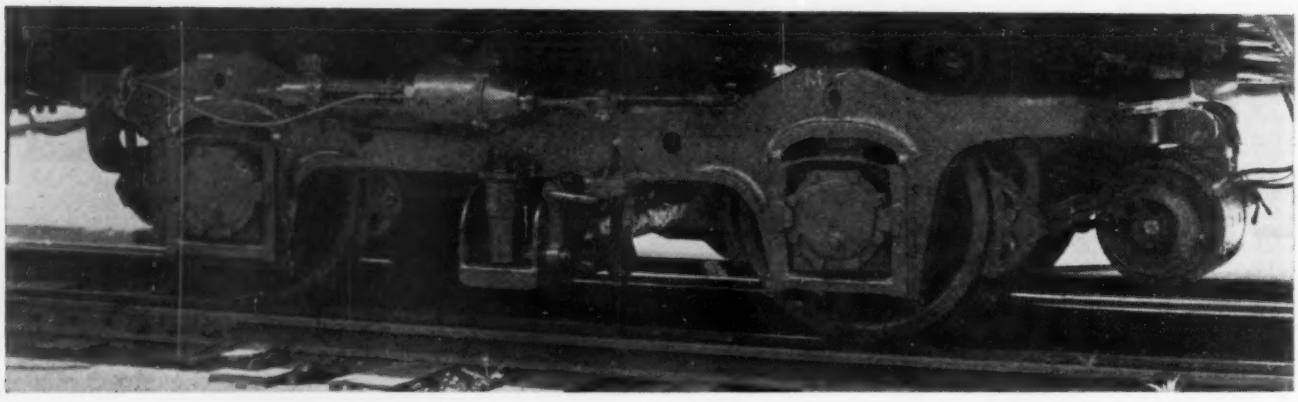


FIG. 10 NONEQUALIZED TRUCK USING A SINGLE NEST OF COIL SPRINGS OVER THE JOURNAL BOX

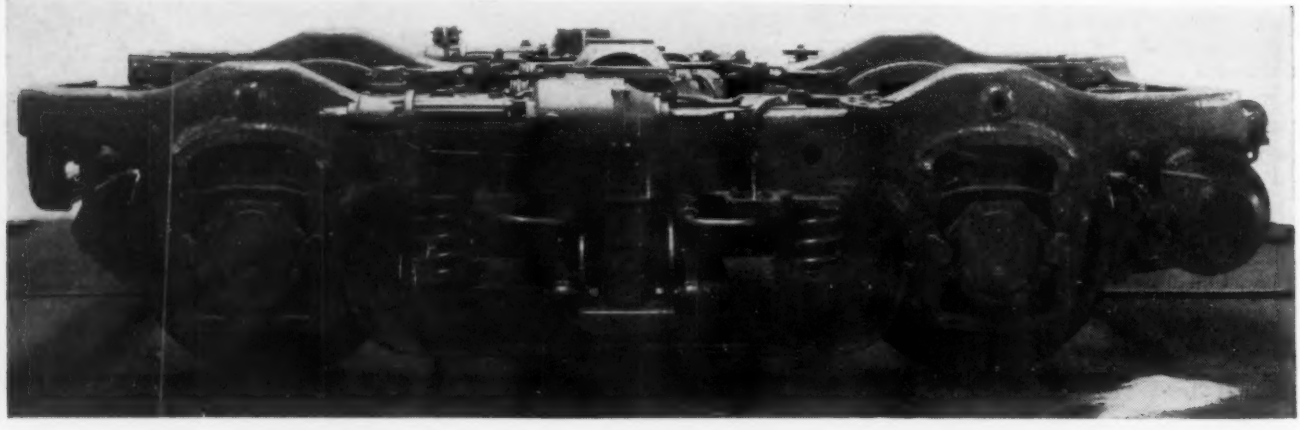


FIG. 11 TRUCK SHOWN IN FIG. 10, WITH HELICAL SPRINGS OVER JOURNAL BOXES ELIMINATED AND WITH CONVENTIONAL EQUALIZING SPRINGS

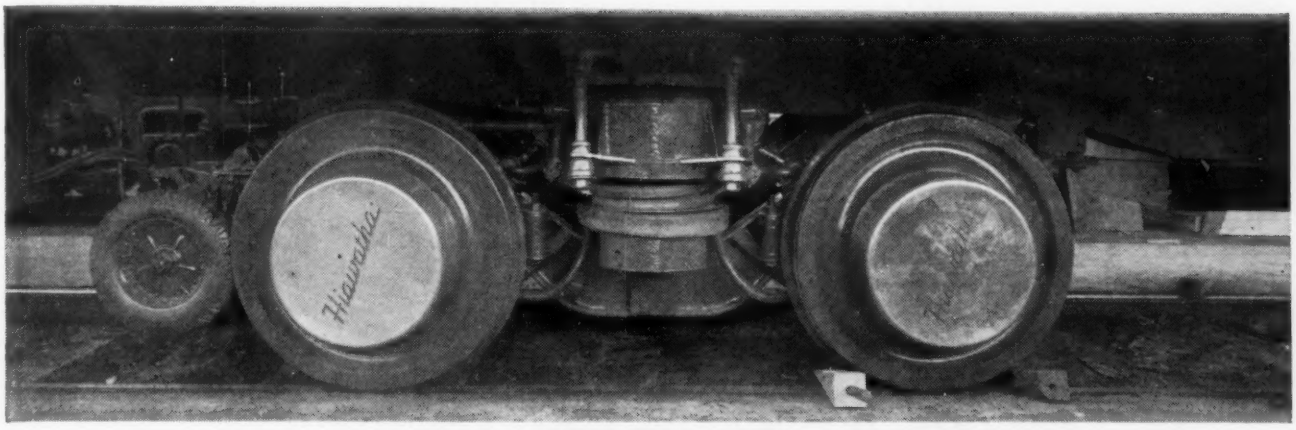


FIG. 12 INBOARD TRUCK WITH ROTOR BRAKE

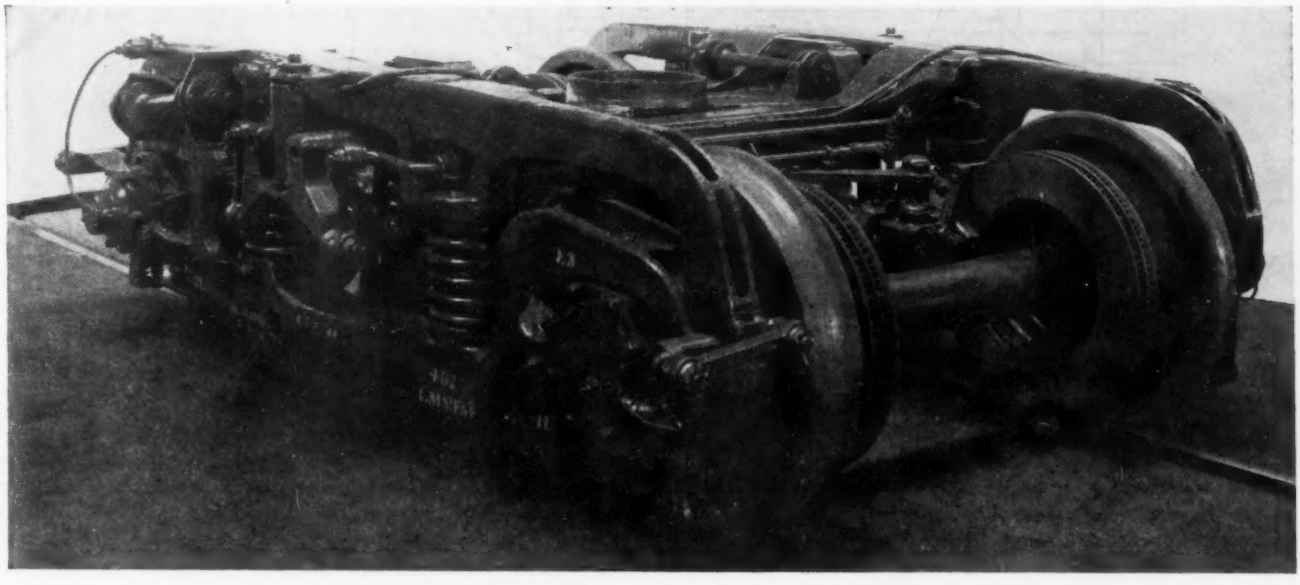


FIG. 13 COACHES BUILT IN 1942 WERE EQUIPPED WITH THE IMPROVED TRUCK SHOWN

New coaches, built in the year 1942, were equipped with trucks as shown in Fig. 13. In this truck the conventional pedestals were eliminated and cast-steel equalizers were employed; the ends of the equalizers being formed to receive the roller-bearing boxes, the equalizer movement being spaced and controlled by rubber-cushioned guide members. This design eliminated all friction surfaces subject to wear with the exception of the swing hangers.

QUALITIES SOUGHT THROUGH RESEARCH

The foregoing is a brief outline of our search for an improved passenger-truck design having the following desirable qualities: (*a*) Safety; (*b*) improved riding qualities; (*c*) reduced weight; (*d*) lower noise level; and (*e*) elimination of friction surfaces.

(*a*) *Safety*. In our development and test work safety has always been the criterion. At the outset careful observations are made of the action of the trucks to detect any unusual behavior which would impair safety. We believe the truck developed for the 1942 cars is safer and more reliable than any truck we have heretofore produced, because the equalizer also forms the pedestals and, in a derailment, the truck parts seem to hold together to a greater extent than in a conventional truck, helping to keep the cars, with the aid of the center-plate locking pin, on the right of way.

(*b*) *Improved Riding Qualities*. At the outset we were determined to maintain the elliptical springs and improve the riding qualities by increasing their deflection. As the elliptical spring has a variable frictional resistance depending upon the condition of the friction surfaces, and as this type of spring, under weather conditions we have to contend with, will often freeze into a solid block, we experimented with helical bolster springs. Finally one nest of helical springs was adopted at each end of the truck bolster, with a large outside diameter, in place of the elliptical springs. This new helical spring had a free height of $22^1/_2$ in. and a solid height of $10^1/_8$ in.

We also stubbornly insisted on absorbing the initial blows from the wheels by means of springs above or in the immediate vicinity of the journal box as that seemed to be the most logical and economical place for them. After making many futile attempts with helical, semielliptical, and volute springs and rubber cushions, we had to resort to an equalized truck and locate the helical springs at a distance from the journal. In experimenting with a large number of springs at various locations and with varied deflections, it appears that there is nothing greatly wrong with the location of the springs in a conventional passenger truck if physical conditions permit applying helical springs of suitable characteristics.

Helical springs used as standard for freight cars have an oscillating frequency of 216 cycles per min and pass through their first critical cycle at a speed of about 45 mph for fully loaded cars. In the latest 1942 Milwaukee passenger cars built in company shops, the springs have an oscillating frequency of 88 and 59 cycles per min for the equalizer and bolster springs,

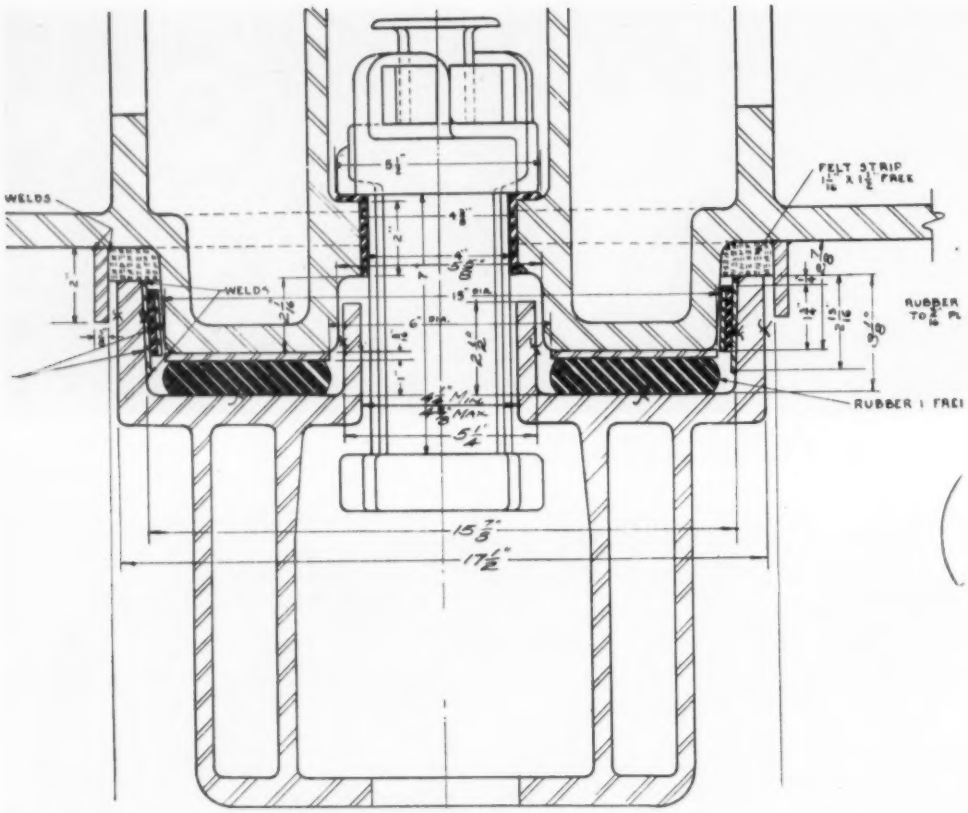


FIG. 14 TEST ARRANGEMENT OF TRUCK-BOLSTER CENTER PLATE FITTED WITH RUBBER CUSHIONS TO REDUCE NOISE TRANSMISSION

respectively. The truck goes through its last critical cycle that we have been able to observe, at 26 mph, which is far below the operating speed. We have been unable to discover any additional critical cycle above 26 mph, although we have reached speeds up to 126 mph. There is no way of knowing whether the combination of springs selected represents the best possible installation but we do know that so far the riding qualities have been improved in almost direct ratio to the lowering of the oscillating frequencies of the springs. With soft springs, shock absorbers and levelizing bars are requisites.

(*c*) *Reduced Weight.* The weights of four-wheel experimental trucks, without generators, varied from 12,870 to 18,723 lb. With careful redesigning and the use of high-tensile steel and the liberal use of aluminum, it is estimated that trucks can be built to weigh approximately 13,000 lb, or 26,000 lb per car set.

(*d*) *Lower Noise Level.* We have aimed to reduce the noise level inside the car. Anyone who has tried to discover the sources of noise will appreciate that this is a difficult problem. Assuming that most of the noise originates from the truck, we have probably taken some unusual precautions and in so doing have obtained unusual and unexpected results. One of our first attempts to control noise at a connection, which was considered to be vulnerable for transmitting noise from the truck to the car body, was the center plate. We therefore laid a 1-in-thick rubber cushion bonded to a $^3/_{16}$-in. steel plate, in the truck-bolster center plate; in addition, the periphery of the center plate was insulated with $^3/_8$-in. rubber which was bonded to sectional steel plates. This arrangement, shown in Fig. 14, was applied for test purposes in the year 1938, to a dormitory car in Chicago to Seattle service and one of our engineers, at the time of the application, wrote his initials and the date in yellow chalk on the face of the steel plate. After this car had been in service 19 months the engineer's initials were still legible, which proved that instead of the usual rotational movement between the steel surfaces, the 1-in-thick rubber had sufficient rotating flexibility to take ordinary curves.

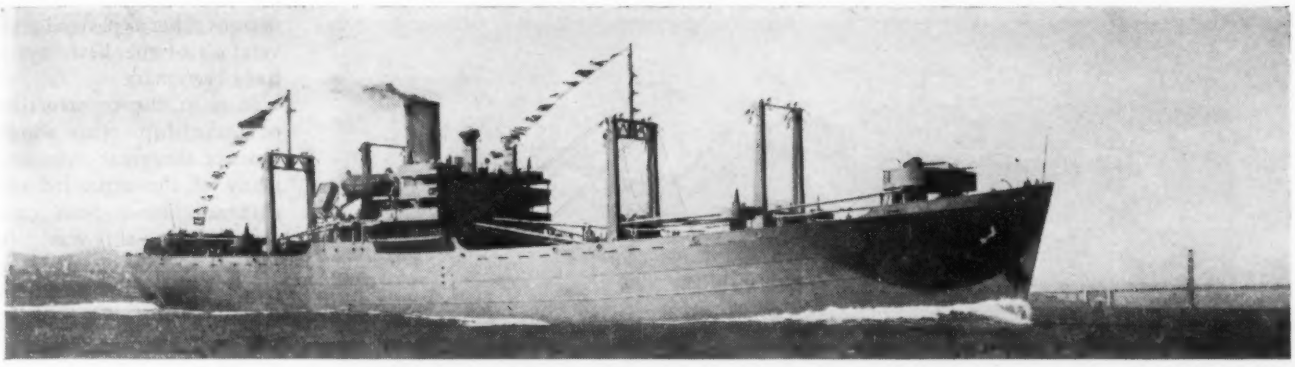
The car in question had been in the service mentioned, operating through the mountains where there are many 10-deg curves. By employing rubber insulation freely between truck parts metallic contact creating noise has been reduced. Continuing our search, it was discovered that although we had, to the best of our ability, insulated the truck from the car body, there is a fertile field for study of sources and transmission of air-borne noises to the inside of the car through tubular vertical end door-posts in the frame of the body and the vestibule itself, a discussion of which, however, is outside the scope of this paper.

(*e*) *Elimination of Friction Surfaces.* Friction creates wear and consumes power and both add to the expense of maintaining passenger-car trucks; its elimination means increased life and less adjustment of parts. By introducing the rubber between the truck and body center plate, as previously mentioned, all wear on those members was eliminated and we know that the life of the rubber is more than 6 years, having had some in service for that length of time. By means of rubber-mounted guide members the wear in bolsters, boxes, and pedestals, which previously existed, has been eliminated.

The swing hanger and swing-hanger pins are subject to severe wear. From experiments now being conducted it appears that we can dispense with the swing hangers entirely and allow the large bolster spring to take care of the lateral motion between truck bolster and truck frame. At this time it would seem that the wear of truck parts can be confined to wheels, roller bearings, and brake parts. The life of the other parts would depend on the fatigue or durability of the materials employed.

ACKNOWLEDGMENTS

Acknowledgment is given to the General Steel Castings Corporation which has co-operated with us and has designed and furnished all cast-steel parts used in several truck designs. Their engineers have also been of valuable assistance and have participated as observers in most of the road tests. The engineers of the Railway Steel Spring Division of The American Locomotive Company, the Monroe Auto Equipment Company, and the United States Rubber Company have also given us valuable assistance.



S.S. "JOHN LAND" C-2 TYPE FREIGHTER

Some Aspects of SHIPBUILDING *During* WORLD WAR II

By JAMES R. MOORE

VICE-PRESIDENT, MOORE DRY DOCK COMPANY, OAKLAND, CALIF.

AMERICAN shipbuilding, which has produced some of the most glorious ships ever conceived by the mind and fashioned by the hand of man, has had a disproportionately large share of vicissitudes throughout its history. A glance at the record of shipbuilding in this country will reveal the extreme fluctuations that have plagued the industry from its inception. In general, the periods of greatest shipbuilding activity during our history have been during the nation's wars, but there have been some exceptions to this. One was the era of clipper-ship construction in the 1840's and 1850's, during which so many bewitchingly lovely ships slid down the ways of American shipyards to establish records for speed that were the envy of mariners and seafaring nations throughout the globe. The period from 1914 through 1922, which may roughly be classed as the World War I shipbuilding era, saw American shipbuilding rise to unprecedented levels with the construction in the peak year, 1919, of a total deadweight tonnage of 5,061,813; but, alas, ship construction speedily declined from the zenith reached in 1919, to a nadir that the industry required nearly two decades to pass.

With a renewed demand for ships at the outbreak of World War II, in 1939, the shipyards once again experienced a great surge of activity, so great as to dwarf all previous standards of accomplishment. World War II shipbuilding reached its pinnacle in the year 1943, when a grand total of 19,238,626 deadweight tons of commercial shipping was delivered from American shipyards. The years 1941, 1942, and 1944 were likewise tremendous years for the shipbuilding industry of the United States, but they were somewhat below 1943, the record being 1,088,497 tons in 1941; 8,089,732 tons in 1942; and 13,555,878 tons, January, 1944, through October, 1944. The United States became the world's greatest shipbuilding and shipoperating nation; the Pacific Coast became the greatest shipbuilding section of the United States; the San Francisco Bay area became the greatest shipbuilding area of the Pacific Coast; and as an area the greatest shipbuilding center in all the world.

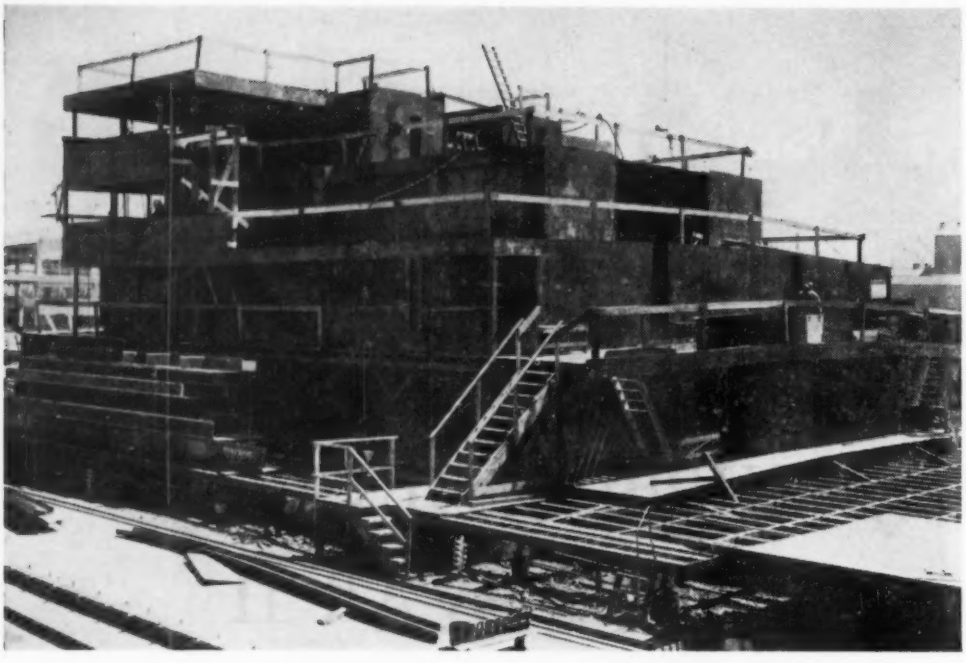
The author's company has played a not unimportant part in the revival of large-scale shipbuilding on the Pacific Coast, having been awarded the first Maritime Commission contract on the Coast; this was in 1938. This firm, therefore, has enjoyed an enviable opportunity, not only to witness but to participate in the tremendous expansion that has taken place in the nation's shipbuilding establishment. Many astonishing, and indeed revolutionary developments have occurred in the industry within the last few years, some concept of the nature and extent of which it is the author's desire to describe.

Presented before a meeting of the San Francisco Section, San Francisco, Calif., Nov. 11, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Abridged.

REVOLUTIONARY METHODS DEVELOPED IN SHIPBUILDING

During the present war, the shipbuilding industry has been able to transform itself into what is not far from a mass-production and, in some cases, indeed, an assembly-line industry. During the first world war, although the volume of construction was immense and while a considerable measure of standardization was achieved in certain American yards, notably Hog Island, mass production, or to use a more precise term, "multiple construction," had barely made its advent into the shipbuilding industry. The adoption of multiple-construction techniques did not follow suddenly upon the entry into the shipbuilding field of industrialists who, having never built ships before, brought a fresh and daring point of view to their newly acquired shipbuilding responsibilities; on the contrary, it was an evolutionary process that had its roots in the shipbuilding boom of World War I. But World War II, with the extensive use of flame-cutting and welding that have characterized this era, brought with it the greatest exploitation of multiple-construction techniques in the shipbuilding industry that the world has ever seen. Commencing with double-bottom, bulkhead, and deck sections, and extending to side-shell, superstructure, stern, and bow assemblies of ever greater weight and complexity, this process has reached a point where entire superstructure sections are being constructed on true assembly-line principles.

Great things have happened in shipbuilding during recent years. Perhaps in the great yards of the West Coast, where space for expansion has been virtually unlimited, have the modern techniques of shipbuilding reached their full flowering. A listing of some of the factors that have been responsible for the



ASSEMBLED MIDSHIP HOUSE READY FOR ERECTION ON C-2 TYPE VESSELS, MAY 1, 1943

greatly increased productivity of shipyards today over former years would doubtless give great prominence to the following:

1 The introduction of welding to shipbuilding.
2 The extensive use of flame-cutting in shipbuilding.
3 The subassembly and preassembly of the major parts of the ship before erection onto the hull itself.
4 The liberal use of very large-capacity cranes for handling the afore-mentioned preassemblies.
5 The application of the techniques of multiple construction to the shipbuilding industry, and painstakingly careful scheduling and sequencing of construction.

BASIC TYPES OF MERCHANT SHIPS

While space does not permit the enumeration of the many types of ships that have been built during the present war, the principal dimensions and characteristics of the basic Maritime Commission types are listed in Table 1, since these have served as the prototypes for great numbers of ships built or converted to meet special requirements for war service.

The C-type ships comprise the foundation of the United States Maritime Commission long-range program but the transportation exigencies of this global war demanded the construction of many ships of a simple type to make good the frightening losses of ships on the high seas resulting from enemy submarine action. Accordingly, a type known as the Liberty, and later, when turbines and gears became available in a more plentiful supply, another type known as the Victory ship were designed by the Maritime Commission and constructed by the nation's shipyards in response to this need for a great number of ships in a short space of time. From these basic designs other types and conversions of the basic types have been made.

It is in the construction of these ships with which most of the great new and many of the expanded old shipyards have been concerned during this war. In general, the C-type or long-range type of Maritime Commission ship is a finer, faster, more commodious, more efficient type of ship than the Liberty or Victory ships. The long-range type ships are geared-turbine- or Diesel-propelled, are equipped with electrically driven pumps and deck auxiliaries, and are of a finer and more elegant finish and quality throughout than are the short-range ships. The Liberty ships, on the other hand, are powered by reciprocating steam engines with steam-driven auxiliaries, are slow, although with reasonably good accommodations, and have been known as the "work horses of the sea." The Victory ships represent an intermediate stage, since, although they are equipped with geared turbines or Diesels, the efficiency of the steam plant, in the case of the turbine drive, is somewhat less because of fewer stages of feedwater heating and other reasons than the corresponding steam-powered C-type ships. However, they are proving to be a satisfactory and economical type of ship.

TABLE 1 BASIC TYPES OF U. S. MARITIME COMMISSION SHIPS

Type	Length over-all, ft-in.	Speed, knots	Deadweight, tons
C-1	418-0	14.5	7500
C-2	460-0	15.5	9000
C-3	492-0	16.5	12000
EC-2 (Liberty)	441-6	11	10800
AP-1 (Victory)	455-3	15	10800

ENGINEERING FOR STANDARDIZED DESIGNS

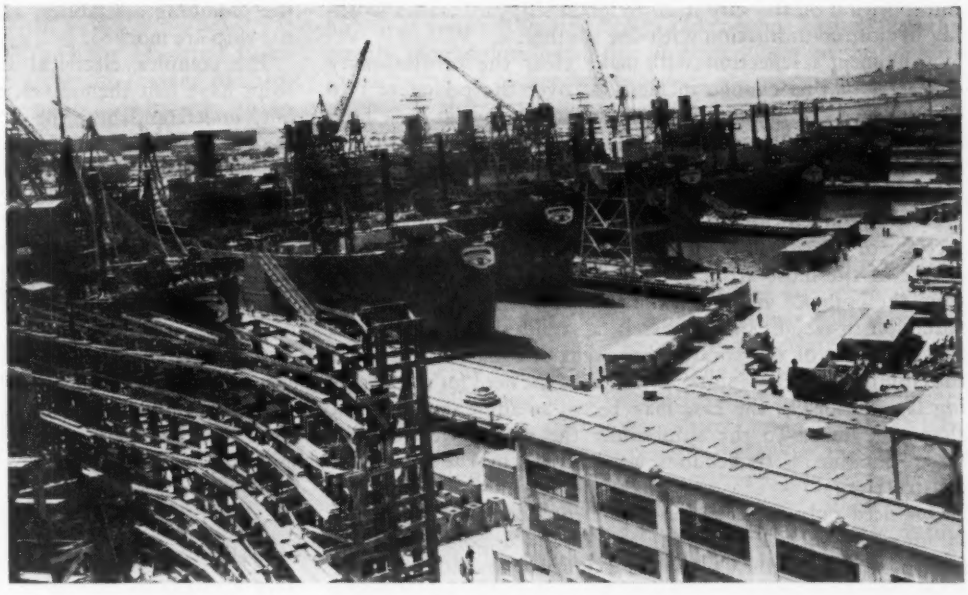
The emergency shipyards of World War II, which sprang up with such rapidity, did not for the most part find it necessary to perform a great deal of engineering or design work, owing to the fact that the ships they were called upon to build were of a standardized type. Indeed, for that matter, had they been asked to prepare their own designs, most of them would have been quite ill-prepared to undertake such a task, for they lacked the skilled naval-architectural and marine-engineering personnel for design work. Even in the detail designing of the ships, much of the work was performed either by one shipyard with experienced personnel acting as a prototype shipyard or by designing firms of naval architects and marine engineers.

However, certain western yards did perform detail design work from the basic Maritime Commission designs. Changes in the design and the inclusion of the conversion features in ships under construction at new yards have created more than a small measure of difficulty during the war; in the case of certain troopships, these difficulties have become vexing to the point where they have seriously interfered with progress. At this date, most of these problems have been solved by better organization on the part of the designing firms as well as by improved liaison between the designing firms and the building yards. Thus much of the engineering work of the industry during this war has been performed by firms other than those actually building the ships.

PLANNING AND SEQUENCING SHIPBUILDING OPERATIONS

The use of mass-production methods in shipbuilding demanded the most careful and pervasive scheduling on the part of the shipyards concerned, if rapid and efficient construction were to be obtained. With some of the larger yards building

the simpler types of ships, general planning and the sequencing of operations that is a part of planning have come to be highly developed; the construction of Liberty ships at the California Shipbuilding Corporation in Southern California, or the assembly of superstructure sections at the Richmond Shipyards assembly line, most assuredly partake of the nature of true factory methods. Indeed, in at least one yard, the practice of referring to the process of constructing the ship must not be referred to as shipbuilding; instead, the plant is known as a "ship factory."



C-2 TYPE VESSELS
(Dimensions: Length over-all 459 ft, 2½ in. × beam 63 ft; displacement 13,860 tons; at fitting-out berths, August 3, 1944.)

The sequencing of hull, engineering, and outfitting installation has been carried to such a high point of efficiency that the progress of construction can be sequenced on a daily and in some yards on an hourly basis, and, what is more, actual performance will vary scarcely at all from the sequence. It is this sequencing that made possible the gradual reduction of time of construction of Liberty ships, for instance, from an average of 241 days from keel-laying to delivery during the first month of their construction, January, 1942, to an average time of 39 days in December, 1943. This sequencing entails, in turn, a thoroughgoing control over the flow of material from receival at the warehouses, which in many cases may be spread throughout the community in which the shipyard is situated because of the lack of sufficient space within the yard itself, through the shops to the assembly areas, craneways or wharves, thence to the assembly areas or hulls, where it is claimed by the requisitioning craftsmen for installation into the ship.

The vast amount of paper work that is necessary to accomplish the smooth and orderly flow of material has been the subject of no little complaint from craftsmen who are accustomed to a simpler and, to them, more straightforward methods of procuring materials; but the enormity and complication of the entire process of building ships on a multiple-production basis absolutely necessitates a considerable amount of the greatly maligned red tape.

PURCHASING MATERIALS AND EQUIPMENT

It is interesting to note the sequence involved in planning and constructing ships. From the detailed plans, prepared by the company's engineering department or purchased from some outside firm, bills of material are sent to the planning department where a decision is made as to whether to purchase, manufacture, stub from stock, take from scrap, purchase from used material, or procure in some other way the material required for the particular ships at hand.

After this decision has been made, the next department concerned, in most cases, of course, the purchasing department, is requisitioned for the material. The purchasing of material during World War II has proved to be one of the most difficult of all the concatenation of events leading from engineering to delivery of the ships. In these days, unlike the old-time practices in shipbuilding, it is customary to purchase such major components of a ship as the boilers, engine, condenser, pumps, and miscellaneous engine-room auxiliaries, as well as the steering engine, windlass, warping and cargo winches, and anchor, and the joiner work from outside firms rather than to manufacture such components in the yard itself. This is symptomatic of a trend toward specialization which has reached new heights in the industry during the present war. But despite the purchase of so many of the parts of a ship in very large components, as indicated by the foregoing examples, and notwithstanding the centralized purchasing performed by the Maritime Commission itself for many components of the Liberty ship program, a shipyard purchasing department still has a task of the greatest extent and complexity.

After an article has been purchased, stubbed from stock, or otherwise procured, and has been received and is available in the storage yard, warehouse, or storeroom, it is requisitioned as needed by the construction and outfitting departments. It is then dispatched by Ross carrier, truck, or other means of transportation to the shops, assembly areas, or hulls for assembly or installation on the hull by the requisitioning craftsmen. Throughout the entire sequence from engineering, planning, purchasing, receival, storing, and operations, a careful control is maintained by the material- and production-control departments.

HULL CONSTRUCTION

A great difference in the modern shipyard as compared with practice 25 years ago is the relative lack of operations now performed in the plate shop. Then, steel plates flowing through the yard had to be laid out, center-punched, punched, countersunk, and in some cases joggled and scarfed in the plate shop before going out to the hull. On the hull itself the erection of the plates was a laborious, time-consuming, piece-by-piece fitting of each plate into its respective position and the bolting-up, riveting, unbolting, and calking of rivets and plate edges. Today the process has been simplified in the extreme. Steel plates and shapes coming into the plant require, in most cases, very little layout, and the cutting of the plates to size can be accomplished by a multigraph burning machine that stack-flame-cuts many plates simultaneously. These plates, which frequently need have no rivet holes whatsoever punched in them, can then go directly to the subassembly or assembly area for erection on a large double-bottom section or superstructure section, etc., as the case may be, amid circumstances of good light and ventilation. The next step, of course, is the placing of the large sections, which may weigh upward of 100 tons,

into position on the ship itself by giant shipyard cranes working in close co-ordination with one another.

A moment's reflection will make clear the revolutionary character of this change in methods over the period of two decades, and the great savings in time and cost that have been brought about as a result. Welding, which also has played a revolutionary part in the shipbuilding industry, has lessened the weight as well as the cost of ship construction and has greatly simplified the task of fastening together the plates and sections of the ship.

One of the most attractive aspects of welded construction from the point of view of the ship operator, of course, is the reduction in weight of the vessel; a saving that may amount to 15 per cent of the total lightweight of the hull because of the elimination of lap joints, as well as of the need for the fastening leg or side, as the case may be, of an angle stiffener or a channel frame. To the shipbuilder the use of welding has made possible a tremendous acceleration in the tempo of construction.

One need only consider for a moment the difficulty of performing the necessary riveting work in a double-bottom or forepeak tank, and the endless labor of fitting and fastening the riveted sections together to realize the saving that welding has made possible. During this war, "Unionmelt" welding has been used to perform hundreds of miles of bottom, tank-top, side-shell, bulkhead, deck, and superstructure welding with incalculable savings of time and effort. The dense, strong, homogeneous, smooth, beautiful weld produced by this process has endeared this type of welding to shipbuilders the country over.

Here again, if the author may be subjective, it is a matter of interest to note that not only was the "Unionmelt" welding machine invented in the Bay Area, but that its application to the shipbuilding field as a practical, rugged, durable tool, suitable for the rough-and-ready use given to such tools in a shipyard, was accomplished at the yard with which the author is associated, due not so much to the foresight of the yard itself as to the propinquity of the yard to the laboratory of the inventor. The use of this process has undoubtedly been a factor of great importance in expediting ship construction during the war period.

OUTFITTING OPERATIONS

Profound changes have taken place in the outfitting phases of ship construction in addition to the hull-construction improvements mentioned. With the unbelievably large contracts that have been let during the present conflict, many other possibilities of mass production, work simplification, and more efficient techniques have presented themselves to all departments. One of the most striking of these is that of the prefabrication or mocking, as it is called, of piping. Today in the typical large shipyard with a considerable number of ships of one type to build, experience has indicated the advisability of constructing a mock-up of the ship's engine room with the engine, condensers, pumps, and interferences all faithfully reproduced to make possible the prefabrication of piping.

In place of the awkward, slow, fit-and-try method of making up piping on the ship in the cramped, congested, and crowded engine room, pipe is now fabricated in the mock-up with remarkably improved efficiency. Indeed, piping for the engine room of the ships under construction at the author's yard can now be mocked with man-hour requirements of fewer than 1250 per ship, while under the old system of preparing the pipe inside the engine room 4800 man-hours were required; a saving of 3550. This process of prefabricating pipe has been extensively applied, it happens, with the author's yard, and all of the engine-room piping between the tank top and the engine-room floor plates are mocked as well as a good deal of additional engine-room pipe immediately above the engine-room floor plates. In addition, the ship fire line on the main deck, the plumbing assemblies, and various other lines throughout the ship are mocked.

The complex electrical installations aboard many modern ships have lent themselves, to some extent, to prefabrication, but, understandably, the opportunities are far more limited than in the pipe-fitting field. However, kick pipe and stuffing-tube-area insert plates have been prepared for the areas in which the electrical cables pierce the decks or bulkheads, respectively, and various new methods of running cable have been developed.

Following the trend in other crafts, joiner work and sheet-metal work are prefabricated in the shop to the greatest practical degree, with a minimum of prefabrication work being performed aboard the hull itself. A significant step in this direction is to be found in the boilermaking trade where at present entire boiler assemblies weighing as much as 45 to 50 tons are fabricated outside the shop away from the ship and are lifted aboard complete directly onto their foundations. It may be said that one of the most significant developments in shipbuilding during the war has been the performance of work in the shop rather than on the ship itself.

PROBLEMS OF SHIPYARD ADMINISTRATION

Thorny and sometimes exasperating have been the problems that presented themselves in the administration of this stupendous shipbuilding program to the managements of the country's shipyards. The author's company, which, as previously indicated, was engaged in shipbuilding at the outset of the present expansion, has lived through and endured these administrative problems and is in a position to speak with the voice of experience about them. Not the least important of these questions has been that of training the vast hordes of new workers who flooded into the plants after Pearl Harbor. Elaborate training programs had been established, but because of the incorrigible tendency of many shipyard workers to quit their jobs in shipyards and remove to another after only a short period, the training job has never been completed.

Furthermore, one can readily visualize the departments that have been needed to cope with the problems of labor turnover, recruitment, training, discipline, morale, selective service, gasoline rationing, counseling, housing, and transportation, to say nothing of the basic and tremendously expanded administrative functions of timekeeping, accounting, statistical work, and estimating that must be performed at all times. The problem of maintenance, for example, reached a stature of tremendous importance involving hundreds and sometimes thousands of men in its performance.

The compelling necessity, from the point of view of the war effort as well as from the point of view of the shipyard manager, of using the most efficient work practices, methods, and techniques called for the establishment of departments variously known as systems and methods departments, efficiency departments, or industrial-engineering departments. The author's company found that the contributions made by this particular department in its plant yielded the very greatest dividends in improved efficiency of operations in such fields, particularly, as hull fabrication and pipe fitting.

CONCLUSIONS

As we endeavor to peer into the future of the American shipbuilding and ship-operating industries, we cannot but be troubled by a consideration of the fluctuations that have characterized the fortunes of these industries in the past. True, the volume of shipbuilding performed by this country during the past 3 years has far exceeded any comparable shipbuilding effort in all history. The entire world has been dazzled with the story of this accomplishment. Yet we must not lose sight of certain salient points, important among which are the following:

1 Because the United States Maritime Commission has been foresighted, American shipyards had had a considerable period

of time during which to prepare themselves for the current conflict.

2 The Jones-White Act of 1928, and the Maritime Commission Act of 1936, insured that a certain amount of shipbuilding would be performed by the nation's shipyards during the period between World War I and World War II.

3 Much of the shipbuilding effort of World War II has been of a simple type in which a vast tonnage could be produced with relatively unskilled labor recruited from kindred industries.

4 Many of the keymen in both the design and construction phases of the industry received their training in Europe many years ago and migrated to this country. It is improbable that we shall receive as immigrants many artisans of this class in the years to come, for the supply of such highly skilled labor from Europe has been largely curtailed.

Let us resolve to insure that there will be at least some ship designing and shipbuilding in important and strategically situated American shipyards at all times henceforth. To allow our yards to lapse into a state of desuetude would be a most shortsighted and unfortunate folly, the consequences of which might possibly be an ignominious and humiliating defeat of our country in war or a frightful prolongation of some future conflict in which we might become involved. The economic interdependency of nations; the shrinkage of distances through improved means of transportation and communication; and the greatly increased vulnerability of any country to the unmitigated horror of rocket bombardment are several factors that emphasize the importance of being constantly prepared. A moment's consideration of the part played by ships in supplying the offensives being mounted concurrently by the United States on opposite sides of the globe impels one to the realization of the indispensability of the ship in global warfare.

Let us resolve to do our part to support the shipbuilding industry in its legitimate endeavor to maintain itself in a condition of perpetual preparedness against the day when it may again be called upon to serve a nation at war. Those whose businesses suffered a decline in volume of activity during the few years of the great depression will understand the demoralizing and debilitating effect of a depression upon an industry. Imagine, if you will, an industry subjected to a depression lasting nearly 20 years and then being called upon to produce its particular product in fantastic quantities immediately at the end of that depression.

The shipbuilding industry has performed a miracle during World War II. We must make sure that it will be similarly well prepared to perform other miracles in the unpredictable future if it is called upon to do so.

BOILER WEIGHING 52 TONS FULLY ASSEMBLED IN BOILER SHOP BEING INSTALLED IN HULL 254 (MC 1167) C-2 TYPE FREIGHTER ON THE WAYS UNDER CONSTRUCTION, AUGUST 30, 1943

EDUCATION FOR WHAT?[1]

By IRVING KNICKERBOCKER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROF. W. B. Donham of the School of Business Administration at Harvard in his book[2] entitled "Education for Responsible Living" offers both criticisms of, and constructive suggestions for, improving the educational procedures followed in both liberal arts colleges and technical schools. Although his book is mainly devoted to the liberal arts college, I am going to pull out of it some of the material applying to the technical school at the risk of making Professor Donham appear in the role of a critic of the technical school alone. His thinking has been based on many years' experience with thousands of graduates of both liberal arts colleges and technical schools. He has had in the course of training them an opportunity to compare their abilities and their previous training. In addition, he has had considerable opportunity to learn the businessman's point of view on the problems which boys are going to be expected to face and deal with.

If we conceive the product of the engineering school to be education, then there are two classes of consumers to be satisfied, the students and the industrial managers who employ the students. Both classes of consumers have complaints to make about our product. The student, often the better student, when he complains is apt to talk about the narrowness or one-sidedness of his education, the lack of opportunity for coming to grips with real problems. He is apt to express some doubt as to whether his four years at technical school have prepared him adequately for facing life. The manager, when he complains, talks about certain inadequacies of the engineering graduate as a unit in management, about his inability to handle problems and make decisions realistically, about his inability to move wisely through the tangled mazes of human problems, about his inability to manage men and handle labor relations. If it were possible to utilize only the technical abilities of a man and utilize them where technical abilities alone were necessary, the industrial manager would probably not complain. However, technical graduates as well as the rest of us working in industrial organizations are confronted with a kind of world in which there are many problems for which technical training alone is no preparation.

"Most of the activities of men are carried on in the world of uncertainty." "The unknown and the unknowable are not to the man of affairs, as they are generally to the natural scientists, things to be studied if he so desires at some future convenient time. They are pertinent facts which he can rarely know in time for use in current problems." "Our leaders of all grades must make policy decisions and get things done not only where the certainties of science are involved but in the world of uncertainty and change." "The major problems of industry and government are not technological or even economic questions which arise out of the immediate environment. Their origin is social. They are concerned with human relations, the relations of business and government, international relations, public opinion, and widespread discontent; with the breakdown of the capacity to co-operate; with the maladjustments of human beings to changes which affect seriously the lives of most of our city folks and all of our farmers." "Among the aspects of experience which make men stand out in practical life are background and the ability to use it, judgment, capacity to make decisions and carry them out, and skill and understanding in dealing with human problems." This is the practical world of industry as Professor Donham sees it. Unless the graduate of the technical school is to be employed solely within his technical capacity and exist in industry in a vacuum shut off from the current of human affairs, this is the world in which the technical graduate must be adequate. Professor Donham goes on to say that "although technical engineering is the career for which most engineering courses directly fit men, outstanding success in life is not usually attained through this approach. Success more often comes either through distinguished research or through a transition to industrial management. Men in both these types of careers need breadth of vision not given by the present curricula of engineering schools."

Let us, then, inspect in the frame of reference of the real industrial world in which the technological graduate is to work a picture of him given by Professor Donham after some 40 years of experience with the products of technical schools. "His difficulty is the narrowness of his point of view. For him the material world is abstracted from human life. The fact that interests him is the fact that stays put, that recurs, that can be weighed and measured. He is at home with scientific methods which in the material world give assured results from assured measurement, logic, and mathematics. On the other hand, he is disturbed by the confusion of facts as they occur in other aspects of life. He resents, often explicitly, the necessity of formulating judgments in important situations in which many significant facts are not only unknown but perhaps unknowable and few can be weighed or measured. He is inclined to take it for granted that a conclusion logically reached on an adequate technological basis should *ipso facto* be ordered into effect. Even when he recognizes that his engineering methods cover only part of the situation, he generally assumes that this part of the whole will dominate and that human behavior and other factors will adjust themselves to the technological objective. His training goes a long way toward unfitting him to bring into his thinking the human or social facets of life, or to deal wisely with uncertainty." Professor Donham cites the experience of a new professor in the business school who at the end of an hour of teaching pointed out that another professor disagreed with the views which he had put forth. "A student in the back row hastily gathered his papers together and when the class was adjourned rushed to the desk, saying, 'I object. I came here to learn business and the very first hour I am told that two professors disagree. I object.'" I have had this experience myself not once but several times. Students vary from being sympathetic with the professor of a subject in which all professors do not agree, to being alarmed or indignant at being exposed to such confusion. Such an attitude, to whatever extent it exists, will scarcely be conducive to success in the uncertain world.

Professor Donham devotes the latter half of his book to suggestions for dealing with this problem in education. His suggestions are made for use in the liberal arts college but do not seem to me totally inapplicable to schools of technology.

At the business school it is found that considerable time is consumed in breaking down the attitudes mentioned in the description of the technological graduate in order to prepare the ground for a more realistic approach to the problems of the industrial world. Perhaps this suggests one approach to the

(*Continued on page 329*)

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "Education for Responsible Living," by Wallace B. Donham, Harvard University Press, Cambridge, 1944, 309 pp.

PREPLANNING *of* LOGGING OPERATIONS *for* MINIMUM COSTS

By DON M. MATTHEWS[1] and JOHN A. WILLARD[2]

LOGGING presents an extremely variable production problem. In industry, under conditions of repetitive manufacture, the production problems remain more or less constant for considerable periods of time. Under these conditions planning of the production process and the development of a minimum cost of production has received a tremendous amount of engineering and management attention. The result is that under these circumstances costs are usually at a minimum and, furthermore, what has been done in the past is a reasonably accurate indication of what costs may be in the future.

In the logging industry, however, practically no two stands of timber are alike, and even in the same section some factors of production cost may be markedly different, resulting in radical changes in operating cost.

This extreme variability of operating conditions has made it difficult to set standards for operating cost. There is a real need for a knowledge of what operating costs *ought* to be for comparison with what they *are*. As an example, it has been customary simply to turn the logging job over to an experienced woods boss and relax with the feeling that he is going to do whatever needs to be done to produce the work as inexpensively as possible. Experience, however, has indicated that this is seldom effective in bringing about a minimum cost of operation. Again, experience with the methods outlined in this paper indicates that it is usually possible to cut costs by at least 25 per cent through the application of these methods as compared with leaving the planning to the rule-of-thumb management of a woods boss no matter how competent.

As an example of these needs for variable operating standards, there was the case of a study of one year's operations in logging on a chance in the Sierra Nevada Mountains on heavy timber. During this season under study, the costs were found to be about $2.75 a thousand board feet more than the general average of the past or the general average of adjacent competitors. Analysis showed that more than half the production for the season had come from a series of deep canyons where operating costs were extremely high.

Advance estimates and a knowledge of what these costs were likely to be would have forewarned the management and shown the desirability of logging these areas only in times of high prices, or high taxes, or both.

Or, if the need for logging these areas in conjunction with adjacent sections was imperative, the higher costs would have been recognized in advance and due allowance made for them in budgeting operations. The techniques described herein permit a predetermination of what operating costs should be in areas that vary over a wide range of conditions. They thus permit valid current comparisons with what costs actually are and a setting-up of real yardsticks of operating efficiency.

Again, these standards may be utilized to permit the adoption of incentive methods of pay so that personnel may be adequately compensated for accomplishment against these standards.

[1] University of Michigan, Ann Arbor, Mich.

[2] Partner, Bigelow, Kent, Willard and Company, New York, N. Y. Member A.S.M.E.

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Incentive methods of paying wages have been used in the woods in connection with the standards developed through the use of the technique herein described. The management can amply afford to pay the woods crew a bonus for keeping costs down to the standard, because, as previously stated, the adoption of these preplanning methods can result in an over-all reduction in cost of probably not less than 25 per cent as compared with the best operations carried on without the benefit of preplanning.

Space does not permit presenting the details of such a plan herein.

PREPLANNING TECHNIQUE

Moderate to considerable changes in the method of production must be planned for in advance as the operation moves from a stand of one character and density to another, from one size of timber to another, and encounters varying types of topography and ground cover.

Under such circumstances the data of past cost may be of little value in estimating future cost. Production must be planned for and cost estimated currently as the operation proceeds. At least a preliminary or approximate cruise must be made to provide a knowledge of the volume per section and the nature of the stand. Comparisons of cost by one method of production versus another will be constantly in demand and methods of quickly determining the most efficient plan of production without resorting to slow and laborious total-cost comparisons are essential to the prompt decisions which are often demanded.

The technique of determining in advance the plan of operation which will result in minimum cost and maximum efficiency in the use of labor and equipment rests upon a knowledge of what factors control cost and the manner in which this control is effected. Broadly all costs of logging fall into two categories:

Direct Costs. Labor and machine costs incurred in felling, bucking, skidding, loading, and transporting logs.

Fixed per Acre or per Year Costs. Funds expended to prepare the logging area for the operation of labor and machines and to supervise and direct their work.

The justification for expenditure of funds in the "fixed cost" category lies in the reductions thus to be obtained in the amount of funds expended in the "direct cost" category. No justification can be found for an increase in fixed-cost expenditure unless a more than compensatory reduction in direct-cost expenditure can be anticipated therefrom. Conversely, a decision to refrain from incurring a fixed-cost expenditure should not be made until the result of such expenditure upon direct costs has been measured and found unsatisfactory. Success in planning and managing a logging operation depends upon ability to determine when and how fixed expenditures are justified and should be increased and when and how they are excessive and should be reduced. The objective in planning will always be that of achieving a minimum for the sum of direct and fixed costs when they are both expressed per volume unit of output. Consideration of the way in which fixed-cost expenditure will affect the cost of the various direct operations and methods of measuring the effect are therefore of prime importance.

Log-making (felling, marking and limbing, and sawing) is

the first step in the production process. The cost of this operation is largely that of direct labor and simple direct machine cost. For the most part it is independent of the volume per acre and fixed-per-acre expenditure and varies with the species, timber size and form, topography, and ground cover—all factors which are fixed for the particular logging chance. It is, nevertheless, an important cost item which can be controlled only through instruction of the workmen and development of production standards. Such expenditures are more likely to be fixed per year rather than fixed per acre.

TRANSPORTATION COSTS

After completion of the log-making process the remainder of the logging operation is almost entirely a problem in transportation. It begins with off-the-road skidding or hauling and continues through steps involving a demand for progressively higher types of loading equipment and road facilities which all contribute to fixed-per-acre expenditure. Every step in the process compels a decision as to how much should be spent on facilities which are fixed to the site in order to reduce the cost of loading logs and moving them toward the delivery point. Obviously, such expenditures are recoverable only by spreading their cost against the volume of timber which is to be extracted. Such expenditures can be kept low, but if this is done, the direct costs which they affect will be high. A low-class exterior road can be constructed which might cost but a few cents per thousand board feet for the timber on the total area served by that road. In that event a high hauling cost will be incurred for every thousand board feet or cord of wood which is extracted. Low-class interior roads can be constructed and spaced at wide intervals but then the cost of skidding timber to them and of hauling over them will be high. Logs can be loaded by cross-haul at roadside instead of at the landings required by more efficient semistationary loading equipment; but in that event the cost of lost time on trucks while loading will be increased although the cost of skidding the timber to landings will be greater than that of skidding it direct to roadside.

At every step in the transportation process a minimum-cost balance must be struck for the sum of a fixed-per-acre cost and the direct cost which is complementary to it. To strike such a balance the direct cost must be known on a volume-unit, distance-unit, or work-unit basis; the facilitating fixed-per-acre cost must be calculated; and the volume per acre which is to be extracted must be known so that the fixed cost can be spread against it. In summary form the information necessary to preplanning a logging operation for minimum cost may be listed as follows:

1 Volume per acre to be extracted for each "side" or other logging area unit
2 Skidding:
   (*a*) Fixed cost per thousand feet board measure or cord for hooking, unhooking, and turn-around time
   (*b*) Variable cost of skidding 1000 fbm or one cord a unit distance such as a chain or a station of 100 ft
3 Loading:
   (*a*) Direct cost of machine operation on a time basis
   (*b*) Time to load per thousand ft board measure or cord inasmuch as this will govern vehicle stand-by cost per volume unit
4 Cost of landing preparation and of moving and setting up loading equipment
5 Hauling:
   (*a*) Stand-by or idle cost of truck per hour while loading and unloading
   (*b*) Running cost of truck per hour
   (*c*) Load carried
   (*d*) Speed of truck on roads of various types
   (*e*) Time to unload truck at delivery point
6 Costs of construction of roads of various types correlated with the speeds which trucks can maintain over these roads.

A considerable portion of the foregoing data can often be obtained from the records of an operating company, although it will usually not be available in the form indicated. Some data will normally have to be obtained from observation and timing of operations on the ground—particularly the loaded and empty run speeds of tractors and trucks and the fixed time of these machines at loading and unloading points. A trained observer can usually obtain the information necessary to the preliminary preplanning of an operation within a week or ten days, but no operator should attempt to make permanent use of such data. Arrangements must be made for its continuous collection so that it will be constantly up to date. This does not mean that an established system of cost accountancy need be scrapped and an alternative method adopted to acquire the necessary unit-cost data. Rather it means that certain data will pass through different channels to the cost accountant, reach him, perhaps, in a slightly different but quite as useful form, and be used in transit to tell the cost story of the future instead of merely being recorded by the accountant to tell the cost story of the past. This procedure is likely to bring about a readjustment of any rigid cost classification which may be in effect and a recognition of the fact that certain so-called "fixed costs" are not the inflexible budget items that they appear and that other so-called "variable costs" are, in part, fixed and should be so treated.

With data such as the afore-mentioned available, the technique of planning the operation so as to achieve a minimum sum for the total of fixed-per-acre and direct costs is neither difficult to understand nor apply. Broadly speaking it rests upon a recognition of the fact that, as fixed-per-acre costs are incurred to reduce direct costs, it will pay to increase any fixed cost as long as such increase, when expressed per volume unit, results in a more than compensatory reduction in the complementary direct cost.

SETTING UP COST FORMULAS

Any fixed cost can be expressed per volume unit as F/VA where F represents the total cost of the facility (road, landing, or other improvement fixed to the site), V the volume per acre, and A the area against which the cost is to be spread. Any direct cost can be expressed as $C \times D$ where C is the cost of moving the product (1000 fbm or cord) a unit distance and D is the distance through which it must move. Either C or D may be controlled by the value of the quantity F or the way that quantity may be spread against the area on which the volume of timber to be removed is found. If these two cost components can be set down in terms which will express both area and distance, and if volume is known, it will be found that a minimum for their sum will be obtained when the values of the two components are equal. A very high volume-unit fixed cost resulting from spreading the total cost of the facility against a small area will decrease very rapidly on a reciprocal curve as the area it serves increases. The complementary direct cost will increase at a constant rate. Prior to the point at which they are equal the volume-unit fixed cost will fall more rapidly than the direct cost increases; after that point it will fall more slowly. This being the case it is merely necessary to equate these two cost components in terms which will permit the solution of the equation for any cost factor over which control is to be effected.

The best approach to the development of equations which can easily be solved to determine the quantity of any controllable factor which will bring about equality as between fixed and direct volume-unit costs is that of writing total-cost formulas and the selection from these formulas of the cost components which should be brought into balance. To illustrate, assume that the following cost data are available with regard to a logging operation:

F = fixed cost of tractor skidding..... $1 per M fbm
C = variable cost of tractor skidding per station of 100 ft..... $0.20 per M fbm
r = cost of spur-road construction..... $4 per station
S = spacing of spur roads..... 25 stations
L = cost of loading trucks (includes truck stand-by charge)..... $1.23 per M fbm
H = cost of truck hauling per station of 100 ft..... $0.013 per M fbm
D = average length of spur roads..... 10,000 ft or 100 stations
V = average volume per acre..... 10 M fbm

A total-cost formula which will express the transportation cost per thousand board feet for logs on trucks at the junction of the spur roads with the main haul road would read

$$\text{Cost per M} = F + CS/4 + \frac{r/0.229}{VS} + L + HD/2 \ldots [1]$$

In Equation [1] the expression $CS/4$ represents the cost of skidding logs to the spur roads through an average distance of one quarter of the spacing of the roads. To this the quantity F would have to be added but it would not vary with distance. The average skidding distance would be $S/4$ because the maximum distance would be $S/2$ and the minimum distance would be zero. The complementary facilitating fixed-per-acre cost is the cost of the spur roads per thousand board feet. This can be expressed as $\frac{r/0.229}{VS}$ because, if roads were spaced 100 ft apart, each station of road would serve 10,000 sq ft or 0.229 acres. It follows that $r/0.229$ represents the cost of the roads per acre if they were spaced at intervals of one station; and this quantity divided by the product of the volume per acre and actual spacing in stations determines the cost of the roads per thousand board feet for any volume and any spacing measured in stations of 100 ft. The expression $HD/2$ represents the cost of hauling the timber over the spur roads to the main-haul road because the average hauling distance will be half the average total spur-road length.

The foregoing total-cost formula, Equation [1], is a useful tool for estimating cost even if none of the cost factors involved is subject to control. If any or all are subject to control, the use of the formula directs attention to the cost items which are out of balance. For the production situation as described, cost can be estimated as in Table 1.

TABLE 1 COSTS IN DOLLARS PER 1000 BOARD FEET

	Dollars per M fbm
Fixed skidding cost, F.....	1.00
Variable skidding cost, $CS/4$ or $0.20 \times 25/4$...	1.25
Road construction, $\frac{r/0.229}{VS}$ or $\frac{\$4.00/0.229}{10 \times 25}$.....	0.07
Loading, L.....	1.23
Hauling, $HD/2$ or $0.013 \times 100/2$.....	0.65
Total cost on trucks at main haul road.....	4.20

It is to be noted from Table 1 of unit costs that the variable cost of skidding is about 18 times the cost of road construction per thousand feet board measure whereas, for minimum cost, these two items should be approximately equal. It is conceivable that the topographical features of the territory to be logged might be such as to compel the spacing of roads at intervals of approximately one-half mile. If such were a fact, the cost situation could only be improved by selecting a different type of skidding machine which would be more economical on the long haul required, and by improving the type of road so as to develop a higher speed for trucks and thus a lower hauling cost. Topography, however, rarely exerts such a rigid control over the location of spur roads; and an unsatisfactory cost, such as the foregoing, often exists on areas where roads can be spaced at any desired interval, and goes unchallenged because no cost breakdown, such as the foregoing, has been prepared to draw it to the attention of the operator. If the spacing of roads is controllable, then they should be so spaced as to bring about equality of variable skidding cost and spur-road construction cost per thousand feet board measure. A formula which will determine the quantity of such spacing for any combination of variable skidding cost, road-construction cost, and volume per acre can be developed by equating the variable-skidding-cost component, $CS/4$, and the road-construction-cost component, $\frac{r/0.229}{VS}$, as follows

$$CS/4 = \frac{r/0.229}{VS}$$

or

$$S = \sqrt{\frac{17.4r}{VC}} \ldots\ldots [2]$$

Substituting the appropriate values from the production situation here being discussed we have

$$S = \sqrt{\frac{17.4 \times 400}{10 \times 20}} = 5.9 \text{ stations}$$

Cost for variable skidding and road construction can now be estimated in dollars per thousand board feet as follows

Skidding, $CS/4$ or $\$0.20 \times \frac{5.9}{4} = \$0.295$

Road construction, $\frac{r/0.229}{VS}$ or $\frac{4/0.229}{10 \times 0.20} = 0.295$

Total..... $0.59

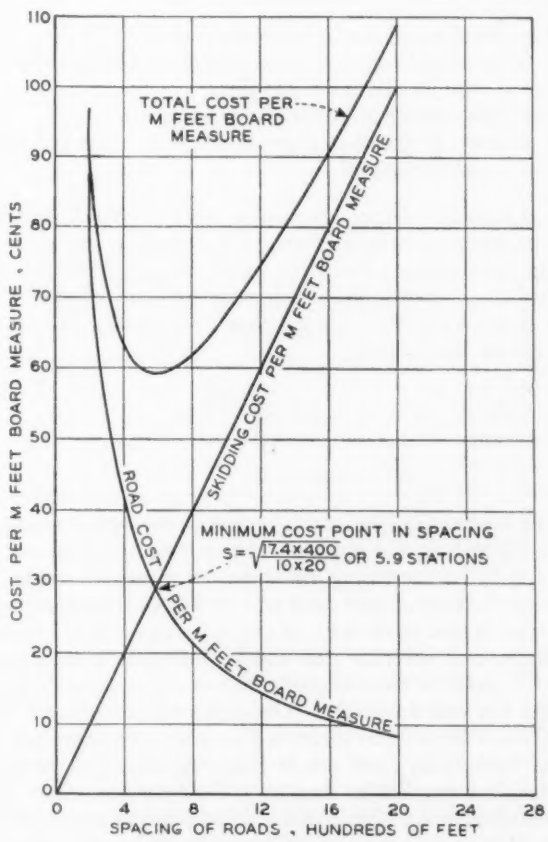

FIG. 1 VARIATION IN SKIDDING COST, ROAD COST, AND TOTAL COST WITH SPACING OF ROADS

The cost reduction brought about by this simple preplanning technique amounts to \$1.32 minus \$0.59 or \$0.73 per M fbm, a total of \$7.30 per acre for the area included in the logging chance on account of variable skidding cost and spur-road construction cost alone.

A chart which illustrates the operation of this formula for the determination of road spacing is shown in Fig. 1.

HAULING COSTS

For the production situation here being discussed, this is the major cost reduction which can be effected through proper planning for the use of the equipment which has been assumed to be available. However, two other cost items, hauling and loading, will merit investigation. A hauling cost of \$0.65 per M fbm for hauls averaging only about one mile is clearly excessive, and a breakdown of this cost is indicated as the first step to determine whether or not it can be improved. This cost depends upon the machine rate for the trucks being used, the loads they carry, and the speed they maintain on the type of spur road which is being provided. Investigation might develop the following facts:

Machine rate for trucks:

Fixed per hour cost (stand-by or idle time cost).....	\$1.45
Operating per hour cost (costs which accumulate only when truck is running).....	1.00
Running cost per hour.....	\$2.45

Average load, 1.2 M fbm

The unit hauling cost per thousand board feet per station of hauling distance for any truck can be determined from a formula which reads

$$\text{Cost per M fbm per station} = \frac{2HC}{G \times L \times 52.8} \quad \ldots\ldots [3]$$

where

T = truck running cost per hour, in this case \$2.45
L = average load carried, thousands of feet board measure, in this case 1.2 M fbm
52.8 = the number of 100-ft stations per mile
G = average round-trip travel speed in miles per hour, undetermined

The average travel speed can and should, of course, be determined by timing trucks over the roads which are being used. However, in this case, the unit cost per thousand board feet is presumed to be known and is 1.3 cents, and the average speed can be determined from the formula by inserting the appropriate values, as follows

$$1.3 = \frac{2 \times 245}{G \times 1.2 \times 52.8}$$

or

$$G = 5.98$$

If it be assumed that trucks are carrying their maximum safe load at 1.2 M fbm it is apparent that the hauling cost can be reduced only by increasing the speed of travel of trucks by improving the type of spur road provided them. Improvement of the type of spur roads will, of course, increase fixed-per-acre expenditure and whether this can be justified depends upon the current relative costs of road construction and hauling per thousand feet board measure. Under the revised plan of road layout, roads have been estimated to cost 29.5 cents per M fbm and hauling 65 cents per M fbm. Applying the general rule that, for maximum economy, fixed-per-acre costs and their complementary direct costs should be in approximate balance, it is apparent that some expenditure on the improvement of roads will be justified. The limit of any such increased expenditure as will be justified cannot be determined by direct calculation, inasmuch as it will be governed by the type of improvement required to increase speed and the amount of increased speed obtained. Data as to improvement costs and their effect on speed will be required; and with these in hand comparative cost calculations must be resorted to in order to determine what type of improvement can be undertaken. However, it should be borne in mind that doubling the cost of the roads will not double their unit cost per thousand feet board measure, because, by means of the spacing formula, the spacing will be altered so as to prevent this. Bearing this in mind *it is safe to say that when unit road costs are half or less than half of unit hauling costs, anything up to double current costs of road construction can be incurred, if, thereby, the speed of trucks on these roads can be doubled*. This is, of course, only a generalization and does not obviate the necessity for comparative cost calculations.

Assume that, in the case here being considered, it is estimated by a competent engineer that an improvement in the alignment and grade of the spur roads which are being constructed can be effected at a cost of \$2 per station which will permit trucks to travel at an average speed of 8 mph and that surfacing and the addition of gravel on certain portions of the roads can be effected at the additional cost of \$3 per station with a resulting speed of 16 mph for trucks. The following comparative cost calculations are now in order:

Costs which will be affected by a change in road type are, in cents per thousand feet board measure, under the current plan, as follows:

Variable skidding cost.....	29.5
Road-construction cost.....	29.5
Hauling cost.....	65.0
Total.....	124.0

If alignment and grade of the roads only are improved, construction costs will be \$6 per station and roads should be spaced at $\sqrt{\frac{17.4 \times 600}{10 \times 20}}$ or 7.2 stations. The unit hauling cost per station on these roads would be $\frac{2 \times 245}{8 \times 1.2 \times 52.8}$ or 0.96 cents per M fbm. Costs in cents per thousand feet board measure can be estimated as follows:

Variable skidding cost, $CS/4$ or $20 \times 7.2/4$.....	36.0
Road construction, $\frac{r/0.229}{VS}$ or $\frac{600/0.229}{10 \times 7.2}$.....	36.0
Hauling, $HD/2$ or $0.96 \times 100/2$.....	48.0
Total.....	120.0

If, in addition to alignment and grade improvement, the roads are further improved by surfacing and the addition of gravel where required, construction costs will be \$9 per station. In that event roads should be spaced at $\sqrt{\frac{17.4 \times 900}{10 \times 20}}$ or 8.9 stations. The unit hauling cost on such roads would be $\frac{2 \times 245}{16 \times 1.2 \times 52.8}$ or 0.48 cents per M fbm per station. Costs in cents per thousand feet board measure can be estimated as follows:

Variable skidding cost, $CS/4$ or $20 \times 8.9/4$.....	44.5
Road construction, $\frac{r/0.229}{VS}$ or $\frac{900/0.229}{10 \times 8.9}$.....	44.5
Hauling, $HD/2$ or $0.48 \times 100/2$.....	24.0
Total.....	113.0

It is evident from the foregoing calculations that a much higher type of interior road than was originally planned for is not only justified but is required if minimum cost is to be

achieved. The cost reduction effected by the use of the higher-type road is not great when expressed per thousand feet board measure but, nevertheless, it amounts to $1.10 per acre, a not insignificant sum when large areas are involved. Moreover the use of the higher-type road carries with it nonmeasurable economies such as fewer truck breakdowns, greater daily output, and the possibility of all-weather operation. The average operator recognizes that all these advantages are to be obtained from the use of good roads but usually contends that the expense of their construction cannot be justified. His tendency is always to "get by" with the minimum of fixed-per-acre expenditure and without measuring the results of such false economy upon his direct costs.

LOADING COSTS

The final item of cost which should be examined in this illustrative case is that of loading. This item is always a mixed cost although usually not so recognized. It is made up of the actual direct loading cost plus the stand-by charge of the truck while being loaded. Too often the stand-by charge of the truck is ignored as a part of the loading cost and covered into the total of hauling costs as a hidden item thus obscuring the fact that it may be inefficient loading equipment which makes for high hauling costs and not inefficient hauling per se. In this case the loading cost has been quoted to include the stand-by charge of the truck. It is instructive to see how this item might break down.

Assume that, in this case, loading is accomplished by cross-hauling at roadside with a team and teamster costing $1 per hour. The capacity of the operation is 1 M fbm in 30 minutes and the operation is so planned that the team is kept fully employed. Loading might therefore be quoted at $0.50 per M fbm and, in most cases, would be so quoted. In this case it has been quoted at $1.23 per M fbm, the extra of $0.73 being the stand-by charge of the truck at $1.45 per hour. This method of quoting costs makes it evident that it will pay to increase the efficiency of the loading operation so as to reduce loading time even if this does involve further fixed-per-acre expenditure in the preparation of landings and the moving in and setting up of semistationary loading equipment. The introduction of fixed loading points into the logging program will necessarily change the technique of arriving at the proper spacing of roads. Not only will roads have to be spaced at their economic interval but so will landings. Logs will no longer move directly to roads but will be gathered from rectangular areas to landings located at the centers of these areas. The variable cost of skidding, the cost of roads and landings, the cost of loading, and the stand-by charge of the trucks being used will all have to be brought into satisfactory balance. Space does not permit a discussion of the methods which may be used to accomplish this. It will perhaps be sufficient to state that any logging operation, whether it be conducted on a farmer's 40-acre woodlot or on 40,000 acres of virgin timberland, presents an interesting problem in logistics which submits readily enough to a little practical algebra and plane geometry. And it can be made to yield an excellent return on the cost of administration.

EDUCATION FOR WHAT?

(*Continued from page 324*)

solution of our problem. Is it possible to teach technological subjects without creating the attitude that technology alone can solve all problems and that the technological approach is the only one? It is odd that the effect of subjects such as science or engineering which seem themselves to be entirely realistic should result in creating in students an attitude which is unrealistic. I believe that it is possible to embed both scientific and technological subjects in the matrix of real life in such a way that science and technology are seen in their real relation to living. Most of us have had at least one teacher who brought the whole living world up onto the platform before us and made us see his subject in relation to that world. Teaching of that kind increases understanding not only of the subject, but also of the relation of that subject to life in general.

Professor Donham finds his main solution to our problem in the experience which he has had in the business school with the use of the case method. He believes that students learn to cope with the real problems of industry only by realistic practice in coping with them. He has seen that method work. His account of the use of the case method and his evidence for his belief in its value make highly suggestive reading. Briefly this method presents the student with cases from real life necessitating the making of policies and decisions and the defense of both in situations which demand the same type of thinking as will be demanded from the students in industrial life. This is probably not so far removed in one respect from the type of teaching which the student is already receiving. Just as the engineer is offered a technical problem for technical solution, he might be offered problems chosen from that uncertain world surrounding his technical problem. Someday he may not only have to design a bridge, he may have to run the men who build it. A few courses in which students were set real problems drawn from the executive and administrative fields of industrial life necessitating careful analysis of the problem, an evaluation of the facts at hand, the construction of a policy or the making of a decision, and a further evaluation of the results of such a policy or decision, would train the students in a field requiring new and different facts and skills. At least to a superficial extent the student would find necessary some acquaintance with branches of knowledge other than technology. He would become almost immediately aware of the very important place played in the world of uncertainty by problems involving the relations between human beings in organizations. He should gain a clearer conception of the applicability and value of the skills and knowledge of science and engineering to the problems he will face after he graduates. If he gains no great access in skill in meeting those problems, he should at least achieve an attitude which will make it possible for him to learn more readily, when the time arrives, how to meet them. Any manager of an industrial concern, any industrial-relations man, could furnish the problems. They come thick and fast in relation to government, in handling of wage demands from the union, in labor management relations, in planning policies for postwar changes, in the everyday problems of handling human relations in a situation where nothing stays put.

A broader and more realistic conception of the role in life which the graduate of the technological school is called upon to play may be necessary. If the student is not being prepared to meet the problems facing an engineer in industry, complaints are justified. Ultimately the graduates of technical schools who have tested their education in industry, and the employers of those graduates who have assessed their worth will together indicate the seriousness of the problem and the necessity for solving it.

WHAT *the* ENGINEER CAN DO *in a* SMALL PLANT

[The Metropolitan Section of The American Society of Mechanical Engineers was one of the sponsors of the Conference on War Production and Future Planning presented by the Engineering Societies Committee on War Production in New York, N. Y., on Jan. 30, 1945. One of the panels held in connection with this conference discussed the question, "What Can the Engineer Do in a Small Plant?" Three phases of the subject were considered in the papers which follow.—Editor.]

Product Planning

By GERALD JOHNSON[1]

SHORTLY after the war started, many small plants found themselves in a tough spot. Having no war work, they were among the first manufacturers to lose personnel to the armed forces. Their material supplies, especially for the manufacture of consumer goods, were gradually whittled down and then cut off entirely. A few were fortunate in manufacturing products the Government could use without change. Today, many of these small plants are making articles or parts that bear no relation to their previous facilities. The most important questions in the minds of manufacturers in postwar planning are what to make, and will customers like it and buy it?

What to make is of course a major decision which management must make. Manufacturers must do their own thinking on this matter as many considerations of vital consequence to their business must be weighed carefully before they decide what to make.

Before the war only a few manufacturers knew or could get the answers to this question from within their own organizations. Actually, the answers are supplied by persons within and without the organization and, of course, the customer. The executive, sales, advertising, engineering, production, and accounting personnel all have contributions to make toward the design and success of a new product, and there are many factors to be co-ordinated during all the stages of its development. The following 10 factors are important:

1 What to make.
2 How to make it work.
3 What to make it of.
4 How to make it.
5 What to make it look like.
6 What it will cost to make in labor, materials, overhead.
7 What it can be sold for.
8 How to distribute, advertise, and sell it.
9 What will be the potential net profit?
10 Will it have customer acceptance?

Unless the product has customer acceptance, answers to the other nine questions are unimportant.

How can the small manufacturer find the answer to this question before he invests money in materials, tools, inventory, advertising, and sales expense? Here is an example of the wrong way to do it.

A small manufacturer recently came to us with a design problem. This company had increased its personnel and plant facilities, and had bought into other manufacturing operations foreign to its principal business. One of the subsidiary companies had manufactured certain mechanical equipment for a long time. One of the design engineers proposed what looked like a good idea for the development of a hand-powered unit. He and several other members of the engineering department designed the new product. They made enough working drawings to develop a number of models and ran these models through a series of tests which indicated that the product probably would work efficiently when it was tooled for precision manufacture and assembly.

At this point we were given a set of assembly drawings and the models and asked to take the physical factors as they existed and design the job for the maximum of consumer acceptance and low-cost production.

A study of the problem revealed two facts: The new product was double the weight of competitive products, and the best estimates on materials, labor, and burden indicated it would cost two and one half times as much to manufacture. In addition, the fundamental design was so far out of line that it was impossible to make an attractive salable job of it. About $75,000 had been spent, with the net result that none of the three most important requirements—proper function, competitive price, and sales appeal—could be met.

Opinions of what constitutes correct product-design procedure are numerous. Salesmen's hunches and the artistic technique in themselves are not firm enough foundations on which to develop new products, and the client's personal opinion and prejudices are likely to be no better.

Experience indicates that the answer to the problem is to be found in the client's customer, the ultimate user. This does not imply "consumer research" in the ordinary sense of the term. Something different is needed—a design-engineer-conducted survey. Briefly, this is a survey conducted by the men who design. These men should elicit from the ultimate user by well-planned interviews the information which will result in the design of a product of maximum efficiency and aesthetic value.

Recently a large manufacturer of numerous devices prepared to develop a highly specialized type of equipment for commercial use. To learn what the operators of this complicated device wanted, what features were desirable, and what should be eliminated required prolonged discussion with the operators, for the most part highly trained technicians. The routine type of consumer-research worker would have failed with such men, because the user will give much more information to an interviewer who talks his language.

In a series of preliminary conferences between the design organization and the manufacturer's engineering department, several types of questionnaires, addressed to the management of the firms using this equipment and their operators, were developed. The questionnaires finally approved were a blend of the highly technical information required by the manufacturer's engineers and the appearance and public-interest factors involved in designing the product.

At first some doubt was felt by all concerned as to the reception which the designer-engineer researchers would meet. Each questionnaire contained about twenty questions and called for extended interviews of several hours. In almost every case, however, it was found that the designers were obliged to terminate the interview in order to make train and plane connections.

The client's name was scrupulously withheld in order not to influence the responses. A number of managers and operators,

[1] Johnson, Cushing, Nevell, New York, N. Y.

however, asked that when the equipment was designed, they be notified, saying that they felt that it must be right if it represented the preferences of the customers.

Concurrently with the field survey, a statistical breakdown was compiled in the designer's office. When the engineers and designers returned from the field, a group of directional trend sketches was evolved, growing naturally from the features revealed in the completed survey.

In other cases, too, this modern, scientific approach to product designing is proving of value. A small manufacturer of aeronautical equipment is learning by this method how to design his product for acceptance as standard equipment by airplane manufacturers. A manufacturer of a new type of comfort commodity is able to test the reaction of an entire industry to his product.

It has been said that engineers will be a dime a dozen after the war and that many of our small plants will fold up when they lose their present and only customer. This will not happen if engineers will learn to think all around their problems in terms of potential customers instead of theories and theorems.

Small-plant manufacturers have several advantages over their larger competitors. They can get decisions and turn around fast. The can help themselves tremendously if they will plan now "what to make" and divorce these plans from their production problems. Product development is not a production problem until an idea is developed to a point where it will work and sell. Design-engineering research, conducted in a broad-gage, unbiased manner, free from preconception and representing customer preference, will provide many of the answers. It is new but not impossible.

You have all seen those signs in engineering offices that read: "The difficult we do today—the impossible takes a little longer." I would like to add a newer sign to be hung in every engineering office. "A product incorporating the preferences of customers is assured of a successful market!"

Plant Layout

BY COL. GEORGE S. BRADY[2]

PROPER plant layout can cut costs directly by saving labor and reducing materials in process. There are also many indirect savings, such as unit overhead cost, savings on light, heat, and power, and the more intangible savings derived from less clerical work, less strain on supervisory administration, and fewer factors disrupting employee morale.

Every type of manufacturing plant can be improved by attention to systematic or intelligent layout. It has been argued that the special machinery shop, or the job shop where the parts are made in small lots and vary from day to day, cannot be systematized or laid out in an orderly manner. The argument is fallacious. About a year ago I took over for the Government the production work of a heavy-equipment job shop of some 325 employees, that was far behind shipping schedules. The managers of the plant insisted that it would be a waste of money and time to tamper with the layout. My argument was that the value to shop morale alone would be worth while because even in a job shop where every machine produced is different, the workers take more interest if they can see the product grow from hour to hour. We knocked out partitions, cleared assembly spaces at various points, routed the work by general classifications, and arranged stock bins and stock piles at convenient points, with the result that there was an immediate pickup in quantity and quality of the work throughout the shop. In less than three months the shipments had gone up nearly ten times with only a small increase in manpower.

A manufacturing plant should be considered as a machine, and the progress of all materials and parts through that machine should be considered and planned. It is not sufficient to plan it once in advance. As operations and processes change, and as quantity lots of work in process increase or decrease, there is need for reconsideration of the plant layout. An old method of machine location is to move cardboard templates around on a scale drawing. A more modern method that gives an infinitely better visualization of the shop problem is to have a scale doll-house model of each department or building with accurate three-dimensional scale models of each machine and piece of equipment. These will show actual conditions with clearances for the workers and the work in process. The models will pay for themselves many times over.

The scale models are not the answer to plant layout. They are only the graphic tools to work with during and after planning. Flow charts of the work in process will also be needed; and where many different items flow through the same departments, the flow charts will have to be made up on transparent paper for superimposing one on top of the other in order to plan time intervals to avoid interferences at choke points.

Plant layout is not a one-time job. It is a continuous job because changes are necessary not only with the change in kind of work going through the shops, but also with the lot quantities. Where lots are small it is often advisable to send all parts through to a final assembly department, but in quantity production with relatively unskilled labor, the assembly of units or subassemblies and the stocking of these in storerooms makes an entirely different department layout problem with sometimes a great crossflow of standard production parts like screws, bolts, bearings, and other items. If the plant is of any size at all it is best to have a plant engineer or someone apart from the production superintendent who can visualize the effect on the plant layout of these changes.

The final carrying out of this work should be done by a plant engineer and not by a production supervisor because it involves many managerial factors that a man interested only in production too often ignores or considers secondary. Some of these are the proper spacing of the employees for best working conditions and health, attention to the balancing and convenient location of lavatory and toilet facilities, proper lighting and heating arrangements, power outlets, ventilating systems, and adequate provision for crane and trucking facilities. Some of these are fixed items in the original plant construction and cannot be changed without great expense. Some parts, for example, may require the services of a heavy crane; but by clever planning it may be possible to keep all other assembly parts away from the crane floor until a good point of assembly is reached where the minimum crane-floor work is needed. Likewise, it is not easy to shift water and power lines or sewer connections, and these must always be taken into consideration when shifting equipment. A small number of women workers cannot be scattered among the men at great distance from their own rest rooms. In most states labor laws govern conditions of lighting, heating, ventilation, safety, and sanitation, and it is easy for a man interested only in production to violate these laws. In one recent case a state inspector found 55 law violations after the factory had shifted into war production.

In the layout of a production line, there will be points at which it is desirable to have 100 per cent inspection of the work. These inspection stations should be at spots where it is possible to maintain an even and fairly constant temperature, and preferably they should be closed off or in separate rooms. They should not be located close to heavy equipment that produces much noise and vibration.

Shop offices should be located at convenient points where the foreman can be within easy reach, and where he can have a fair view of much of the shop without the appearance of spying. If time-study men, expediters, or other semi-independent men are attached to a department, a place should be provided where they can discuss problems without being under the eyes and ears of the foreman.

[2] The Douglas T. Sterling Company, Stamford, Conn.

I have not attempted to show specific applications to any particular plant or product. I have preferred to dwell on principles, and I believe that these principles apply to any plant. There is no manufacturing plant, large or small, that would not be benefited by continued attention to layout. It will aid production and reduce costs and material inventories. Good layout will also improve worker morale and better the labor relations.

The following check list covers some of the important considerations in plant layout:

1 A work flow sheet of all the products processed in the factory departments.

2 Provision for convenient receipt of all raw materials. Some quantity materials will go to storerooms; some will go directly to manufacturing departments, such as forge shop or screw-machine department which should be properly located for receipt of raw material and delivery of the manufactured parts to a parts storeroom handy to the using departments. Watch for choke points on elevators.

3 Where supervision demands the grouping of machines of a single type, like drill presses or milling machines, the other departments must radiate from these groups. Sometimes it is advisable to have separate heat-treating equipment in a department to save the confusion arising from repeated back-and-forth trips of parts.

4 Some heavy equipment will necessitate installation on a ground floor. Other equipment will require installation under a heavy crane. Sometimes a slight change in design of the part will permit all operations on this heavy equipment to be done at one time and thus save moving back and forth.

5 Storekeepers are usually jealous of their prerogatives and will want all raw materials stored in a common storeroom. Sometimes it is more economical to provide departmental substorerooms and permit the foremen to draw or receive quantity lots and store them close to the point of use.

6 When the first general layout of machines and equipment is made, check for window space, clearances, lighting, power outlets, ventilation, proper spacing of workers, and distances to washrooms and drinking fountains. See that welding equipment and machines drawing heavy current are not located where heavy power cables must be run through the plant.

7 Check floor loads with inclusion of weight of work in process and in maximum storage. Also check all ceiling and other clearances for the work.

8 Check all trucking and other transportation considerations. Provide ample aisles. Suggest conveyers and chutes where they are economical. Adequate pavements or covered walks should be provided between buildings where there is back and forth trucking.

9 Departments requiring live steam or compressed air must be located conveniently to the sources, or separate provision must be made.

10 Tool cribs are preferably placed in each department, but by clever arrangement they can sometimes be made to serve several departments, with consequent saving in manpower and inventory of tools.

11 Noise is hard on the nerves and interferes with production. See that drop hammers, saws, grinders, and other noisy equipment are away from the majority of workers. Protection should be provided against flashing of welding equipment.

12 In considering these points provide flexibility in each department and on over-all layout, so that changes can be made to provide for changes in type of work or quantity of lots.

13 When the layout is completed, devise a regular, continuous, and scheduled system for the delivery and pickup of mail to and from each department so that each foreman will feel that he is effectively linked into the whole system. This centralized mail system should take care of speedy delivery on regular routes so that departmental messengers are unnecessary.

Shop Equipment and the Engineer

BY A. M. TULLO[3]

WHEN the nature and the amount of the postwar business of a small plant has been fairly well determined, the information should be turned over to a methods-planning engineer for analysis and study. The analysis will establish the manufacturing class of the business. The result may show that the product will be highly diversified, requiring job-shop methods of manufacture, or it may show that the product calls for continuous and repetitive operations. It is quite possible that a combination of both classes may have to be handled. It is important to know this because the class of manufacture will indicate what the equipment will be.

The planning-engineer's study will show that he has broken down the proposed product into individual parts as far as possible. He has planned an order of machine operations for each part and has made an estimate of the time required to perform each operation. With this information and his knowledge of the production quota, he will determine just what type of machine tools are necessary to the successful operation of the shop and how many of each type are required. The competent planning engineer is trained to know the ordinary functions of modern machine tools and he is capable of making his selections intelligently. He will proceed along the following lines.

Certain tools are basic and should be included in any well-planned machine shop, regardless of class of manufacture. These basic tools are not only used for production but they are also essential for the repair and maintenance of the other equipment in the shop and for the manufacture of special tooling, jigs, and fixtures necessary to productive operations. They include the engine lathe, upright drill press, plain milling machine, surface grinder, shaper tool and cutter grinders, cylindrical grinder, and small planer. Thus then, the planner will start by listing the basic machine tools as his first selections.

If the planner has determined that his product falls into the highly diversified class, he will immediately recognize that he will have to employ job-shop methods. Having started his selection with the basic machine tools, he will then expand as required. For instance, if there is going to be considerable lathe work, he will evaluate the use of turret lathes with their flexible tooling combinations and semiautomatic operation.

If the quantity of work permits, the planner will supplement the basic upright drill press with a gang-type drill press with two, three, four, or more stations, and perhaps a radial type of drilling machine for heavier work.

The radial drilling machine makes it possible to drill, tap, and ream heavy work without the necessity of trying to position the work under a fixed spindle as would be required on an upright drill press. The radial and vertical movement of the arm and the traverse travel of the head on the arm give a flexibility that permits a minimum handling of the workpiece. Certain boring jobs are also possible in a radial drill if suitable tooling is applied.

The planner may find it necessary to add a vertical milling machine and possibly a duplex milling machine. The duplex milling machine will mill opposite sides of a workpiece at one time. If some work of this type is to be done it can be seen that the cost of the operation will amount to about half of what it would cost to do the same work on a plain milling machine.

The planner will also consider the necessity of a vertical boring machine or horizontal boring machine for work too heavy for his lathe-type machines. An internal grinder may have to be added, which will also be of great value for maintenance and tool work. Machines of more or less special purpose may be dictated for special operations. Special equipment is available today for the rapid handling of operations such as washing, painting, drying, and wrapping.

[3] Worthington Pump and Machinery Corporation, Harrison, N. J.

The planning engineer must make the decisions as to recommendations for equipment. He will be able to prove the economy of his selections. He will forecast accurately the cost savings in dollars and cents made possible by the selection of a better machine for the job. He will show that the extra cost of the better equipment will be paid for in so many days of operation. The procedure is simple. If one piece of equipment costs $2000 more than another but can produce 12 workpieces in an 8-hour day as compared to 8; and if the labor plus overhead cost of each workpiece is $3, it can be seen that the higher-cost equipment will save $12 labor and overhead cost per 8-hour shift. At that rate the savings will pay for the extra cost of the equipment in about 167 eight-hour shifts. The planner will apply the same reasoning in the so-called manual operations such as deoiling and cleaning of workpieces. It may require three men to do these operations by hand. The use of a washing machine may eliminate the necessity for two of the men, and the cost of the machine would be saved in a short time. Conversely, by the same process the planner will show that it will be uneconomical to invest in certain equipment because of the likelihood of too infrequent or too little use. In some such cases he may recommend the purchase of used equipment.

Selection of material-handling equipment for this job-shop style of operation will favor the flexible type of material movers such as fork trucks, lift trucks, trailers, skids, dollies, pallets, monorails, and overhead cranes. The good planner recognizes that the moving of work and material in any kind of shop is an item that can be expensive if not handled properly. He will strongly recommend that parts in work be kept on pallets, portable skid trailers, dollies, tote boxes, or on any other conveyance that makes possible quick moving by mechanical means. If possible, never put work on floors or benches that will make it necessary to handle this work, piece by piece, by manual labor, because it is quite possible that the total cost of handling may approach the cost of machining.

Inspection equipment for this class of shop will generally be restricted to inside, outside, depth and pitch micrometers, verniers, height and surface gages, plug and ring gages, thread gages, and the like, all selected for the work being planned.

If the planning engineer has determined that the product will be such that continuous and repetitive operations will be the order, he will find out if that situation is going to prevail long enough for him to select, whenever practicable, automatic machines and equipment that will effect savings sufficient to pay for the higher cost of the machines in that time. He will again start with his basic machine tools. To those he will add such of the job-shop tools as he knows that he needs and can justify, but for which he could not justify the substitution of highly automatic machines. From that point he will begin to evaluate the possibility of substitution of automatic tools.

The planner will also weigh the use of a multiple-spindle drilling machine for drilling operations. The machines are expensive but they afford tremendous savings if the volume of work warrants their purchase.

Also available are surface-broaching machines, high-speed milling machines with carbide-tipped cutters, and high-speed planers. Duplicating devices can be obtained for these machines that will permit automatic repeating of tool cycles and reduce tool-handling costs. Automatic precision boring and grinding machines and entirely special-purpose machines for unusual operations can be had if they are warranted. They offer great increases in production and make possible the use of lesser skilled operators. Highly automatic machinery is expensive and often inflexible, and considerable thought must be given to its selection. The cost savings afforded over ordinary methods must be computed in dollars and not in percentages.

Material-handling equipment for this class of shop will include generally the same items as the job shop, but the planner will also consider the application of conveyers, material elevators, chutes, turntables, workpiece injectors and ejectors, and similar equipment. All have practical applications, and if the shop conditions permit, they offer good cost savings.

Inspection equipment also similar to that for job-shop requirements will be necessary but this will be supplemented with automatic sizing devices which are available with this class of machinery. Quick-reading gages of the dial, reed, air, or electric type, comparators, and other special measuring instruments are well suited to highly repetitive work, but again their cost must be justified.

If the nature of the product will be such that a combination of diversified work and repetitive work has to be handled, the planning engineer will consider each item of equipment in both its individual and over-all value to the smooth and economical operation of the shop. His selections will insure a flexibility that will permit efficient handling of work without excessive investment in equipment that may be idle for long periods.

From what has been said, it will be seen that the selection of equipment for a shop or plant is an assignment bearing considerable responsibility. No plant owner can afford to treat the matter too lightly, particularly the small-plant owner. A competent planning engineer is strongly recommended because he has been trained to analyze and solve manufacturing problems. He will suggest changes in design to permit less costly manufacturing methods. He will recommend special tooling to take advantage of the best speeds and feeds available. He will select a class of equipment capable of the performance expected of it. When he makes his recommendations, the plant owner or manager will feel confident that he is getting a plan that has been expertly engineered, and that he can expect to operate at and produce for minimum costs.

MAINTENANCE

The importance of proper maintenance cannot be too highly stressed, particularly for the small-plant owner. If a machine or a process unit in a large plant fails, similar machines or units are usually still in operation, and while production may be retarded, it will not be completely stopped. The small-plant owner probably has only the one machine or unit of its class, and production on the part stops when that machine stops. Immediately one or more operators are idle. To make matters worse, subsequent operation on the part, dependent for continuance upon the production of the previous operation, are affected and they stop.

Recognizing this, many plants are doing their utmost to practice preventive maintenance. They set up a program which calls for the inspection and lubrication of equipment on schedule. A record card is kept for each piece of equipment, the dates for inspection and lubrication are scheduled, and the schedule is followed. The inspector and oiler are required to sign the card each time and to add remarks as to the conditions found. Upon inspection of the cards the master mechanic can determine what, if any, repairs or adjustments are necessary, and can have them made at once. In this manner most surprise breakdowns are prevented. Major rebuilding jobs are anticipated and plans are made to handle them at a convenient time. Delays during the operating day are reduced.

In the small shop where it may not be economical to assign a man to maintenance only, it will prove beneficial to take one of the older experienced men away from his normal operations for periods of time long enough for him to carry on a reasonable scheduled preventive - maintenance program. Do not underestimate this. It will pay big dividends in the long run.

Here again is a situation in which the influence of the planning engineer's thinking is felt. In the selection of equipment he will consider the quantity and quality of maintenance required. He will set up a preventive - maintenance program that is practical. He will insure that the special lubricating oils specified by machine manufacturers for the machines made by them are obtained and used. He, above all, will realize what the cost will be if the maintenance program is ignored.

Some Recent Developments in ENGINEERING MATERIALS[1]

4—*Glasses, Woods, and Glues, Miscellaneous Materials, and Processes*

By ARCHIBALD BLACK

MANAGER, MECHANICAL ENGINEERING DEPARTMENT, SIMMONDS AEROCESSORIES, INC., NEW YORK, N. Y.

GLASSES

GLASS-FIBER APPLICATIONS

THE production of glass in the form of fibers is now a very old art, and some believe it goes back 4000 years, but it has made tremendous advances and has found new applications in recent years. One of the most important of these applications is the use of glass-mineral-wool bats, blankets, or boards for thermal insulation. Mats of glass fibers coated with an adhesive are widely used as air filters. The material has proved highly efficient in both of these applications. The effort to spin fine glass fibers into yarn and into fabrics is also very old, but it is only within recent years that it has become possible to produce yarns and fabrics which are sufficiently flexible to withstand service conditions. Present glass-fiber yarns and fabrics show vast improvement in this respect. Braids, tapes, and cloths woven of glass fibers and impregnated with a suitable heat- and moisture-resistant varnish are extensively used for electrical insulation. The strength of fine glass fibers is almost beyond belief. Textile fibers commercially available (0.00022 in. to 0.00028 in. diam) have tensile strengths ranging from 275,000 to 375,000 psi. Experimental fibers of very small diameter have been produced with tensile strength as high as 2,000,000 psi.

The start of modern development of fibrous glass was made by Owens-Illinois Glass Company, and Corning Glass Works in 1931. By 1936, it was possible to produce glass fibers sufficiently fine to spin into a yarn and weave into a fabric that could be creased and folded without cracking. In 1938, Owens-Corning Fiberglas Corporation was formed to continue manufacture of glass-fiber materials, to carry on further research, and to develop markets. Glass-fiber fabrics are not merely fireproof but are capable of withstanding very high temperatures without damage. A lighted cigarette will char even though it does not burn the ordinary "fireproofed" fabric but it will burn itself out without damaging a glass-fiber tablecloth. Lest this seem to be a departure from the author's subject of "engineering materials," it might be noted that glass-fiber fabrics, in addition to their use as electrical insulation, are used in numerous industrial applications where fabrics that will resist heat, damp, or decay are required.

Two methods of manufacturing glass fibers are in use, depending upon the type of fiber desired. The fibers used for heat-insulation and air-filter purposes are made by directing jets of high-pressure steam upon thin streams of molten glass as they flow from the furnaces. The steam literally yanks the streams of liquid glass into long fibers which are caught on a conveyer belt as a wool-like interlaced mass. In the manufacture of fibers for textile use, a different technique has to be used. This begins by casting refined glass into clear marbles about $^5/_8$ in. diam. After inspection, these are remelted in electric furnaces having small holes through which the molten glass is allowed to flow in fine streams. More than 100 of these filaments are drawn together into one strand as they leave the furnace. The collected strand is wound up more rapidly than the glass streams emerge from the furnace so that each individual filament is drawn out to a diameter very much less than the hole through which it passed. The filament is drawn out so fine that 97 miles of it can be obtained from a $^5/_8$-in. marble.

In variation of the process just described, the glass is formed into textile-staple fibers 8 to 15 in. in length, by the use of the steam-jet process. The fibers are collected on a revolving drum after which they are processed into yarn, using a technique resembling that used for other staples. This whole glass-fiber development is moving very rapidly, and it warrants the careful attention of most engineers for still newer developments that are certain to come.

SPECIAL PLATE GLASSES

Several new types of plate glass have been announced in recent years. One of these, marketed under the trade name of "Thermopane," is a sandwich of polished plate glass with air-conditioned spaces between the adjacent panes. Moisture is removed from the air space and it is then hermetically sealed. The result is to produce a panel of window glass which, under normal conditions, is free from "frosting" as a result of condensation when exposed to cold air on one side and high humidity and warmer air on the other. This panel is being used for windows of vehicles and is also offered for store show windows and house windows. It has also the advantage of eliminating the need for storm windows in cold weather and is exceptionally well suited for use in refrigerator showcases. When used for house windows it has the advantage of reducing the transmission of street noise.

A "heat-absorbing" plate glass has been announced by the Libby-Owens-Ford Glass Company. This is a glass having a chemical composition that transmits light rays but absorbs a high percentage of the infrared or heat rays. In the $^1/_4$-in. thickness, this glass is said to absorb about $38^1/_2$ per cent of the heat rays, as against about $9^1/_2$ per cent for the ordinary plate glass. As the absorbed heat is reradiated partly to the interior and partly to the exterior, the net result is to exclude a greater proportion from transmission through the glass. The external reradiation is naturally greater if there is any wind. It is being used for building windows in cases where it is desired to exclude as much as possible of the sun's heat.

By the application of heat-treatments it has been found possible greatly to improve the toughness and thermal-shock resistance of ordinary plate glass. The process consists of heating the glass to about 1250 F and quenching in a blast of cool air. The result is to produce a glass with greatly changed

[1] The first installment, "Ferrous Metals," appeared on pp. 101–108 of the February, 1945, issue; the second installment, "Nonferrous Metals," on pp. 190–198, of the March, 1945, issue; and the third installment, "Synthetics, Fuels, and Lubricants," on pp. 267–274 of the April, 1945, issue of MECHANICAL ENGINEERING.

Section 4 which falls outside the field of the Metals Engineering Division was not presented with Sections 1 and 2.

characteristics. Libby-Owens-Ford, producers of "Tuf-flex" state that a $^1/_4 \times 24 \times 24$-in. pane of this glass showed a breaking load of 15 psi, as compared with 3.7 psi for untreated glass. Resistance to mechanical shock and to thermal shock is also greatly improved. Molten lead can be poured on a pane of this glass while it is resting on a cake of ice, without damage. When the limit of physical resistance of the glass is finally reached, the fracture is entirely different from the usual type; instead of breaking into jagged slivers, the heat-treated glass disintegrates into small particles resembling bath crystals. This is held to be a distinct advantage as it eliminates much of the hazard that usually follows from glass breakage. Heat-treated glass is now being used for windows of railway cars, gage dials, and other applications where mechanical- or thermal-shock resistance is necessary.

INDUSTRIAL GLASSES

A glass capable of application to exceptionally high temperatures has been announced by the Corning Glass Works in recent years. This is a high-silica glass, containing about 96 per cent silicon dioxide and a balance mainly of boric oxide. It is suitable for use at temperatures ranging up to 900 C (1652 F) for an indefinite period. By way of comparison, it might be noted that the well-known "Pyrex" glass is not recommended for use above 510 C (950 F). The high-silica glass is annealed at 910 C (1670 F), and its coefficient of thermal expansion is exceptionally low, being only 0.00000075 per deg C for the range of 0 to 300 C, thus approaching the expansion of pure fused silica. Surface hardness and flexural strength are high, the latter being 10,000 psi, and the glass has a high resistance to corrosion by nearly all chemicals other than hydrofluoric acid and glacial phosphoric acid. This type of glass is available in the form of rods, tubing, cylinders, chemical-laboratory vessels, and flat sheets. Due to its high cost, its use will be limited to applications where exceptional resistance to high temperature is required.

The same firm has also developed another high-silica glass containing 5 to 11 per cent of titanium oxide which has a still lower coefficient of thermal expansion, but this is not yet on the market.

A type of foamed or cellular glass has been developed by the Pittsburgh Corning Corporation and is being marketed in block form under the trade name of "Foamglas." This material is produced in blocks composed of a structure of glass bubbles containing a gas; it has very low weight, the specific gravity being about 0.17 and, due to being formed of bubbles, it is an excellent heat insulator. The thermal conductivity is given by the makers as being 0.45 Btu/hr/sq ft/deg F/in. at 70 F, which is more or less comparable with the value of cork under normal service conditions. The foamed glass has a most important advantage over most other insulating materials in the fact that it is impervious to moisture, and hence its thermal conductivity is unaffected by atmospheric conditions. It has a further advantage in its suitability for high-temperature applications, the upper practical limit of its use being about 1000 F. The tensile strength of this material is about 100 psi and crushing strength about 150 psi; both are considerably better than most competing materials. Due to its low weight, this foamed glass has been used for floats, in which case its moisture-impervious characteristics become exceptionally valuable.

Several of the important developments in glass within recent years have taken the form of new applications rather than the development of new materials. Among these which might be listed as noteworthy are the use of glass for springs which are exposed to highly corrosive materials. It has been found practicable to apply glass to this purpose where the fiber stress is not allowed to exceed about 2000 psi. Another new application has been the use of glass for sole plates of electric irons; in this case its transparency to infrared rays is used to advantage. Glass has also been used recently for floats such as toilet tank balls, but this began as a wartime expedient due to the shortage of metals and may not be continued.

Reference is made elsewhere herein to some other uses of glass, such as for gages. Hermetic sealing of metal to glass has been greatly facilitated, and the seal improved by a recent development in which metal is fused into a union with the glass to provide a perfect seal. This method is already in use in the construction of some radio components. Experiments are being made on the sintering of powdered glass mixed with powdered metals but these studies have not yet been productive of any commercial applications with the exception of the mica substitute previously described under the trade name of "Mykroy."

OPTICAL GLASSES

Improvements in the stability of optical glass has resulted from the introduction of new methods of annealing. While employing a technique somewhat analogous to that used in heat-treating glass to increase its strength, these methods have a different objective and produce a different end result. The details of the methods have not yet been released beyond publication of some general statements. The new treatments resulted from studies of critical temperatures of the glass, and their application makes it possible to produce a glass having the most important advantage of showing no change in its index of refraction over a period of years. It was found that the removal of internal stresses was not alone sufficient to stabilize glass fully. Pieces which indicated no internal stress under polarized light still showed a slow increase in index of refraction over a period of years, a factor that may be critical in the lenses of precision instruments. As a result, new treatments were developed to "compact" fully the atomic structure of the glass so that it would remain unchanged over a period of years and show a constant index.

Some new optical glasses with higher indices of refraction have also been announced in recent years but the composition of many of these has not been given out. The information on one group of glasses (announced as "sandless" glass, because they contain no silica) shows that they consist mainly of boric acid, zinc oxide, and aluminum oxide, or beryllium oxide. In one variation, cadmium oxide is substituted for the zinc oxide. The index of refraction has not been published other than to say that it is "high" with less than usual dispersion. Research has also been carried out on the problem of improving the light transmission of optical glass by reducing its surface reflection. One of the methods of accomplishing this is that of coating the surface of the glass with a very thin film of certain metallic fluorides. Information on some other methods has not yet been released. Several methods of eliminating surface reflection which would otherwise be effective have proved to be impracticable for some uses as they involve the use of a surface film that is too soft and too easily scratched in service.

GLASS GAGES

Although the use of glass as a material for the construction of plug and ring gages is not a new one, this development warrants inclusion here on account of the tremendous impetus given to it by war developments in recent years. The initial force behind this development was chiefly the critical shortage of steel in the days just subsequent to Pearl Harbor. Since that time, we have passed through the initial stage of overoptimism on the subject; this was followed by a swing of the pendulum to the other direction when it was found that glass gages did not live up to the excessively optimistic original promises. Now that steel shortages are much less acute if not entirely relieved, the glass gage is passing into the next stage in the cycle where it is being reappraised at its true value and may be expected to find a permanent place for which it is particularly

suited. The chief advantages of glass as a gage material are as follows:

1 A glass gage cannot become inaccurate by springing or burring; if dropped, it is either uninjured or it is broken, hence there is no compromise leaving doubt as to its accuracy.
2 Glass affords some visibility in inspection.
3 Since the material is absolutely free from corrosion, it need not be greased for storage.
4 Glass being about $^1/_3$ of the weight of steel results in a lighter gage. While of no consequence in small sizes, this may be a factor of interest in large ones.
5 The thermal conductivity of glass, being very much lower than that of steel, and the thermal expansion also being lower than that of steel, there is less tendency for body heat to cause errors.

While a variety of glasses can be used for the construction of gages, one of the leading manufacturers of these uses a low-alkali-borosilicate glass, mainly on account of its low coefficient of thermal expansion. This same firm also stresses the importance of fine finish of the gaging surfaces, recommending a polished surface capable of reading between 1 and 3 microinches on a surface analyzer, and states that its own gage-grinding facilities make it possible to attain tolerances of 0.00002 in. and surface finish of 1 microinch.

GLASS BEARING JEWELS

The glass-jewel bearing is a wartime development that resulted from interruption of the supply of imported sapphires, although work in this direction had been under way for many years earlier. Successful accomplishment of the desired results was the joint work of the Corning Glass Company, producers of the glass, and the West Lynn Works of the General Electric Company, manufacturers of the finished "jewels." These bearings are made in both the "ring" and "vee" types. The vee jewels are molded to the finished dimension and no additional operations are required. The ring jewels are molded to size on all critical dimensions and the actual bearing hole requires no additional polishing. While the glass jewels have only about three fifths the shock resistance of the sapphires, this is sufficient to make them suitable for use in about 80 per cent of the cases where sapphires were formerly used. It has also been found possible to work the glass to closer dimensional tolerances than were possible with sapphires. The glass bearing shows a coefficient of friction approximately the same as that of sapphires and their cost is very much lower. High-grade, preset, finished, and inspected jewels are now available for as low as 3 cents each, from which it is obvious that they have come to stay.

WOODS AND GLUES

MODERN GLUES AND PLYWOOD

The development of water-resistant and waterproof glues for woods, papers, fabrics, and other nonmetallic materials has branched out to include such a wide field of adhesives that it now covers an extended list of synthetics of the type usually termed "plastics." A very substantial portion of this development took place in connection with the construction of wood aircraft and wooden boats and barges, where requirements are unprecedented in their severity. Low-pressure, high-pressure, and fluid-pressure (or "bag" method) laminating are all used. Without exception, all modern glues are stronger than the woods they are normally used to join. As a consequence, current gluing practice in the aircraft and boatbuilding industries is far ahead of gluing practices in many other fields. A substantial portion of the furniture industry, for example, is still operating largely with nonwaterproof vegetable and animal glues which aeronautical engineers discarded nearly 30 years ago. The glues now in general use in aircraft may be classified into the following major groups:

Casein. This is the same glue that has been with us for many years, excepting that preservatives have been added in recent years, hence the modern casein is resistant to fungus and bacterial attack to such an extent that, except under extreme tropical conditions, the joint sometimes outlasts the wood. (For such extreme conditions, the recent trend has been away from the casein and toward resin glues.) Casein glue is marketed as a powder ready to be mixed with water. It is cold-setting and, after becoming fully set, the glue is highly water-resistant.

Hot-Press Phenol-Formaldehyde Resin. This is one of the newer glues which is largely used in plywood manufacture and is an outgrowth of the extensive development of phenol and formaldehyde resins in the "plastics" field. These glues are marketed in film, powder, and liquid forms; they are thermosetting, the setting temperature varying according to the formulation, 280 to 310 F being the general range. These glues produce waterproof joints.

Intermediate-Temperature Phenolic. Several phenolic-base glues are now available which set at intermediate temperatures of from 150 to 200 F. This lower temperature of setting is an advantage where work cannot be pressed at higher temperatures, such as in heavy, curved, laminated boat keels and ribs. Because of the lower temperatures of setting, these glues have a tendency to set slowly at room temperature, hence the assembly time must be kept low. These glues are available in liquid form and, like the hot-press phenols, are highly waterproof after fully setting.

Room-Temperature Phenolic. These are the newest of the phenol glues, most of them being formulated with a type of phenol resin known as resorcinol, and they offer the same higher durability as the higher-temperature phenols, in addition to the advantage that they can be set at room temperature.

Melamine Formaldehyde. These glues are available in hot-press and intermediate-temperature types in both film and powder form and as water-soluble or alcohol-soluble liquid suspensions. They are water-resistant or waterproof after setting, depending upon formulation. They function much like the hot-press and intermediate-temperature phenolics.

Urea-Formaldehyde Resin. These glues are available as dry powders or in liquid form. They are basically room-temperature-setting but hot-press types are available. Both types are water-resistant after setting. The hot-setting types allow as much as 24 hr for assembly before time becomes critical. Special urea-resin glues, fortified with melamine, have been developed to meet specific purposes; some, for example, are capable of holding a joint even in boiling water. A very long boiling somewhat weakens the wood as well as the joint, but the joint does not show separation.

All of the foregoing adhesives are suitable for the gluing of woods and can be adapted for papers and fabrics. In addition, there is a group of vinyl resins which can also be applied to the gluing of materials, and one member of which (polyvinyl butyral) has, since 1936, been used as a cementing medium in high-test safety glass. There are also several other synthetics, such as the cellulose type and the various rubbers, natural and synthetic, that are also very useful adhesives; some of these are covered separately herein under the head of "metal glues." All of the modern aircraft glues are not only highly water-resistant but they also suffer relatively little loss of strength such as results from overdrying some of the older types of glue; they also offer exceptional immunity to fungus growth when exposed to tropical climates. The extended tests that they have undergone in the aircraft and boatbuilding industries warrants giving them fullest consideration in certain other fields of industry which still continue to use the glues of a bygone age. It is the author's impression that this reluctance to change is due as much to mental inertia as to the higher cost of

the newer glues, since the cost of glue is usually an insignificant portion of the total cost of a product.

GLUES FOR METALS

With the steady progress that has been made in improving the adhesion of surface coatings to metals, it must have been obvious to many that we were headed toward the creation of adhesives that could be used to secure metal to metal. From time to time attempts have been made to effect such a bond but these always fell short of complete success until the advent of some recently developed synthetic adhesives. The most widely publicized of these is the "Cycleweld" process, developed by S. G. Saunders of the Chrysler Corporation. This process utilizes a group of four synthetic thermosetting cements which are used singly or in various combinations depending upon the nature of the two materials that have to be joined. It has been thoroughly tested under service conditions in numerous applications to aircraft. The process consists of chemically cleaning and then applying to each of the two surfaces a thin coat of film of a special synthetic cement and baking to "cure" the film. The two surfaces are then coated with another cement, brought together, and heat and pressure applied simultaneously to cause the films to unite and fully set. It was found by experiment that the cement film should be from 0.002 to 0.004 in. thick. Too thin a film did not show sufficient strength, and too thick a film tends to allow "creeping" of the joint.

The term "Cycleweld" is derived from the fact that a cycle of pressure and heat is necessary to effect the union. The process is distinctly a gluing operation and by no means a weld; there is no chemical combination between the metals and the cement but merely a very high degree of surface adhesion. After the introduction of its original process, the Chrysler Corporation followed with some modifications to suit special cases; these permit making of joints at lower temperatures and with only very moderate pressure.

In addition to Cycleweld, several other synthetic cements have been marketed by other firms for the bonding of metal to metal and metal to various other materials. One of these is "Redux," a synthetic-resin adhesive which was first marketed in England a few years ago and is now being exploited in the United States by the Resinous Products & Chemical Company of Philadelphia, Pa. This adhesive is recommended for metal-to-metal and metal-to-wood joints, as well as for some other applications. Another metal adhesive is "Reanite," which is marketed by the U. S. Stoneware Company of New York, N. Y.; still others are the "Cordo" group of adhesives marketed by the Cordo Chemical Corporation, Norwalk, Conn., for bonding of metals to various other materials including glass. Bonding cements are now available for securing practically any metal to any other metal and to almost any other substance.

CHEMICAL TREATMENT OF WOOD

The chemical treatment of wood is a distinctly separate development from wood impregnation. The difference is in the respect that "chemical treatment" is one that results in a chemical change in the wood itself instead merely of filling or reinforcing the cells with a foreign material. Both the Forest Products Laboratory and the ammonia department of the du Pont de Nemours Company have been contributors to this development; some of the processes have already been marketed, and another will appear in the near future.

The du Pont Company recently introduced the application of urea to the chemical seasoning of wood. This is applied either by dipping the green lumber in a solution of urea in water or by spreading the urea on the surface of the lumber in the form of paste or dry crystals. The effect is to control the seasoning of the lumber so that it dries more evenly throughout and thus reduces the checking and splitting troubles that usually arise in drying. The Forest Products Laboratory found another application for urea in the bending of wood. Green lumber is thoroughly impregnated with urea by soaking in a concentrated solution and is then dried. When heated to about 210 F, the impregnated wood is quite plastic and can be very readily bent; if held in position until it is partly cooled, the shape is retained permanently and the normal rigidity and hardness are regained. Indeed, urea impregnation renders wood thermoplastic to a surprising degree. Several woods were found to respond to this treatment, the hardwoods being particularly suited.

Another recent development in the chemical treatment of wood is the methylolurea treatment, developed by the du Pont de Nemours Company as the ultimate result of some of the research work of the Forest Products Laboratory. This is not yet in commercial use but is now undergoing test by a number of firms and should be in operation within the coming year. The process utilizes "methylolurea," a term used to designate the series of compounds formed as a result of the use of urea and dimethylolurea, the latter being one of the formaldehyde-urea condensation products. The chemical composition of urea is $CO(NH_2)_2$ and that of dimethylolurea is $CO(NHCH_2OH)_2$. Both substances are water-soluble compounds, and the process of application consists of dissolving the two chemicals in water, treating the wood in the solution by use of reduced atmospheric pressure, followed by elevated pressure to effect impregnation, and then drying the materials. The chemicals are converted to resin by reaction with the natural acids present in the wood; heat is not necessary but may be used if desired to accelerate the chemical process. The first stage of the process results in the formation within the pores of the wood of hard, permanent, temporarily fusible, water-insoluble products. This materially increases the hardness and dimensional stability of the wood. If heat and pressure are applied when the resins are still in the fusible stage, the resin will melt, flow, and allow the wood to compress, and quickly become converted (by continued heat) to a final infusible form. This results in a compressed "transmuted" wood which is dimensionally stable, very hard, increased in density, having no open pores, and highly resistant to the effects of moisture. In its finished form, the compressed treated wood compares somewhat with that of the phenol-resin-treated wood described elsewhere. However, while the natural color of the wood is altered by phenol-resin impregnation, it is not affected by the methylolurea treatment.

The various impregnation and chemical-treatment processes offer great possibilities not only in the strictly engineering applications but also in the more everyday ones, such as the construction of furniture, where they retain all of the beauty of the original wood yet impart to it a surface which has no applied finish and is proof against nearly all ordinary forms of marking or damage, such as alcohol stains, scratches, small dents and, to a large extent even cigarette burns. Some of the processes permit use of dyes to give any desired color effect; most of them can be used to impart to the cheaper softwoods a surface hardness exceeding that of rock maple. Due to this, impregnation and chemical treatment make it possible to apply to table tops some of the beautifully grained softwoods that were formerly considered unsuitable because of the ease of damage.

WOOD AND PAPER IMPREGNATION

The impregnation of wood, paper, and fabrics with other materials for the purpose of altering or modifying their properties is far from new but advances of importance have been made within recent years, due mainly to work of the Forest Products Laboratory but also including many contributions by others. The most important recent development in this field is probably the impregnation with one or other of the synthetic resins. Phenol resins of the Bakelite type were among the earliest of the synthetic resins to be applied to wood impregnation and

this practice has been in use for many years. Recent developments in this field have been productive of results sufficient to warrant mention here. The process consists essentially of impregnating wood by immersing it in liquid phenol resin. The initial dipping is now done under reduced pressure (approaching a vacuum) in order to remove as much air as possible; after the wood has been soaked thus for a period that ranges up to a few hours, depending upon the thickness of the pieces, it is then subjected to pressure to force the liquid resin still farther into the pores of the wood. When the liquid impregnation is sufficiently complete, the parts are removed from the impregnating tank and baked to harden the thermosetting resin.

If, as in the case of aircraft propellers, the work consists of multiple plies of thin wood, the process is slightly different. The wood is first impregnated in strip form and is assembled while the resin is still liquid; the assembly is then subjected to pressure and heat simultaneously; the result is a solid block of material consisting of strips of wood impregnated with and cemented solidly together with the resin. Its properties greatly exceed those of wood, and it is completely free from distortion with varying humidity. The assembled block can be machined to its final shape in much the same manner as with a piece of metal. Laminated impregnated wood of this type is marketed under names such as "Pregwood," "Impreg," and "Compreg."

Similar methods are used in the manufacture of parts from resin-bonded plywood, the extent of preimpregnation of the material varying according to the properties desired. Where high strength is required, the preimpregnation is increased; since this results in increased weight as well as in higher cost, preimpregnation is reduced to a minimum in cases where weight is of more importance than moisture resistance and strength. Impregnation has been carried up to 30 per cent, by volume, of the finished article. In general the advantages of resin impregnation may be listed as follows:

1 Greatly increased strength and hardness over that of the original wood.
2 Greatly increased fire resistance.
3 Complete freedom from distortion with moisture, if impregnation is sufficiently complete.
4 Greatly reduced change in weight due to absorption of moisture.
5 Resistance to attack by chemicals is greatly increased and in some cases, complete immunity is attained.
6 Freedom from attack by wood-boring insects, bacteria, molds, marine growth, etc.
7 Readily applicable to molding of curved forms.
8 Can be polished like metal, if well impregnated.

The disadvantages may be listed as:

1 Increased weight over that of wood.[2]
2 Increased cost (varying with extent of impregnation).
3 Somewhat harder to work, as compared with the original wood.

Some variations of the foregoing methods have also been developed, the Forest Products Laboratory being one of the most active organizations in this field. One of these variations is a heat-stabilized wood called "Staypak." This may be solid wood subjected to heat and pressure, but is more generally of sheets of veneer which are coated with a resin-bonding agent and then assembled and subjected to heat and pressure. The resulting material is a high-strength wood possessing most of the characteristics of impregnated wood but not having the exceptional dimensional stability of the impregnated material. Still another variation is "Papreg," which was also developed by the Forest Products Laboratory for use with low molding pressures, such as used in the construction of aircraft fuselages. This is an improved laminated paper resembling the older forms of impregnated laminated papers but having exceptionally high tensile strength and modulus of elasticity. It is made by impregnating a special paper, laminating sheets, and subjecting the assembly to heat and pressure.

[2] Varying from little more than the weight of the original wood up to about the specific weight of phenol resin, depending upon the thoroughness of the impregnation.

IMPREGNATED-WOOD BEARINGS

Some development work has been done in Germany on the application to bearings of layers of red beech impregnated with synthetic resins and compressed under high pressure. The value as a bearing material was found to depend upon many factors including the thicknesses of the layers, the angle between the fibers of the wood, the resin content, the composition of the resins used, and the pressures used in compressing the material. Cooling and ample lubrication in operation were found necessary. In actual operating tests in a blooming mill, bearings of this type were successfully operated at loads of 250 kg per sq cm (3556 psi).

MISCELLANEOUS MATERIALS AND PROCESSES

ABRASIVES

The development of cemented-carbide tools created a need for an extremely hard abrasive medium that could be used in shaping and sharpening these tools. At first, silicon-carbide abrasive wheels were used, and these are still used on large carbide tool grinders. However, the narrow margin of hardness over that of the cemented tungsten carbide left something to be desired, even though this abrasive was satisfactory for many purposes. Diamonds or bort having been used for many years by impregnating in one or other of various metals to form a grinding wheel, attention was turned to the creation of a harder bonding medium for the diamond. One of the methods now in use is the "Carboloy" tool where diamonds are bonded with cemented tungsten carbide; another is the metal-bonded-diamond grinding wheel marketed by the Norton Company, which utilizes a cutting portion of diamonds set in a bond material and secured to a supporting body of synthetic resin. Still another is the synthetic-resin grinding wheel set with diamonds and mounted on an aluminum-alloy body to assist in cooling. The Carboloy diamond-set material is generally furnished as a tool for dressing hard wheels and is rarely used as a bonding material for a grinding wheel, because of the hardness of the bonding material. The Norton diamond-set metal wheel may be run dry or with a coolant; where a coolant is used it can be plain water, soda solution, or a mixture of kerosene and lard oil. The resin-bonded diamond wheel must be operated at moderate temperatures owing to the fact that the bond is affected by heat and may char. For this reason, a coolant is essential; this coolant may be kerosene, plain water, or almost any of the commonly used grinding coolants that are not strongly alkaline.

Within the past decade, these diamond-set wheels have been made successfully in distinctly larger sizes and are now obtainable in sizes up to 20 in. diam. In addition to being used for dressing of cemented-carbide tools, they are also applied to the cutting of quartz, glass, synthetic sapphires, and some of the very hard ceramics such as are used for aviation spark plugs.

Another development in the abrasives field is the Behr-Manning method of making an abrasive cloth by the use of an electrostatic charge to locate the particles on the cloth. This results in a sharper cloth, as the particles align themselves on the adhesive endwise and more or less evenly spaced, instead of in a haphazard arrangement as with older methods. Another important abrasive development is the creation of synthetic boron carbide; this is covered separately herein.

POWDER METALLURGY AND SINTERING

While powder metallurgy is far from being new, its field has undergone considerable development during the last 10 years. Chief advances have been in (*a*) greatly extended field of use,

(*b*) extended list of metals available, (*c*) attainment of almost solid metal density, with even the oxidizing metals like aluminum, and (*d*) in some cases attainment of strengths practically equaling those attainable with cast and wrought metals. The powders now available for sintering include practically the entire list of commonly used metals; producers are now advertising powders of aluminum, antimony, bismuth, brasses, bronzes, cadmium, chromium, cobalt, copper, gold, iron, lead, manganese, molybdenum, nickel, palladium, rhenium, silicon, silver, tellurium, tin, titanium, tungsten, vanadium, zinc, and zirconium. Contrary to an impression suggested by the expression "powdered metals," most of the metal powders used on a large scale are not powdered but are produced by electrolysis, or atomization, or by pyrochemical reduction of the metal salts.

The development of cemented carbides (described elsewhere herein) is one of the outstanding recent achievements in powder metallurgy. Sintering methods are used in producing some of the new magnetic alloys also described elsewhere. Self-lubricating oil-impregnated bearings of sintered bronze have been marketed for years but some new types are suitable for heavy duty, and others are made in sintered oil-impregnated iron to permit high loading in service. Some sintered-metal bearings have also been made of porous material without oil impregnation. In these, the oil is fed to the outside of the bearing and is allowed to seep through to the face, thus giving more even distribution than is possible with solid bearings having oil grooves. One of the methods of producing porous sintered metal is to use lower pressure to obtain less compacting; another method is to include with the powdered metal a measured amount of volatile salts; the heat of sintering drives these off leaving the metal with connected pores, the size of which is controlled by the size of the particles of salts. As much as 35 per cent, by volume, of oil can be contained in the metal by this process.

Iron powder is now being used extensively for the production of finished metal gears, cams, and other parts that would normally require elaborate and precision machining. This has been highly developed during the war and has greatly facilitated quantity production of some small intricate metal parts. As a result of the elimination of much machining, such parts can frequently be produced cheaper by sintering than by other methods. Swedish iron was formerly used for this purpose; when the supply was interrupted by the war, mill scale was utilized by processing to powder. Iron and carbon powders are now being sintered to produce parts of high-carbon steel having a density of as much as 95 per cent of that of solid steel, although around 80 per cent is probably more in accord with production practice.

Another important development of recent years is the manufacture of high-friction metal for clutch facings and brakes. Copper, tin, lead, iron, graphite, and some abrasive material like silica or emery, are sintered together to form a coherent metal with a high coefficient of friction. The advantages claimed for this material are its high maximum operation temperature and its good wearing characteristics. S. K. Wellman Company, Raybestos-Manhattan Company, Cleveland Graphite Bronze Company, Moraine Products Division of General Motors, and Amplex Division of Chrysler Corporation are producing or have produced this type of material.

One of the unique applications of the porous metal that can be produced by sintering is the filter metal now being marketed as "Moraine porous metal" by the Moraine Products Division of General Motors. This is produced from a bronze consisting of 90–94 per cent copper and the remainder of tin. The base metal, in powder, is sintered under pressure to leave pores so that it remains about 50 per cent void in the finished form. The result is a material with moderate tensile strength (4000 to 6000 psi) and porosity which permits free passage of particles up to a predetermined size. It is produced in four grades of fineness passing no particles larger than 0.002–0.005 in. for grade 1; 0.001–0.002 in. for grade 2; 0.0005–0.001 in. for grade 3; and 0.0001–0.0005 in. for grade 4. Being produced by sintering, this material can be premolded to any desired form. It is not advisable to machine this material as the surface may become filled up. To some extent, it can be applied to separation of immiscible fluids such as emulsions into their components if the filter material is "wet" with one of the immiscible liquids before the mixture is allowed to come into contact with the filter.

LUMINESCENT MATERIALS

There are two general types of luminescent materials now on the market and commercially available.

1 The radioactive materials, which generally consist of a zinc-sulphide-based material, which is activated by the presence of a small amount of some radium compound and which glows until the radium is exhausted.

2 The fluorescent and phosphorescent materials which consist of zinc sulphide, cadmium sulphide, strontium sulphide, and calcium sulphide, or combinations of these materials. The phosphorescent pigments may be activated either by black light or daylight, and these continue to glow for varying periods after the activating light is withdrawn. The term "black light" is the generally accepted one for a light source just beyond the range of visible light at the violet end of the spectrum. It "is relatively" invisible to the eye, which accounts for the term black light. Fluorescent pigments are activated by black light only and continue to glow as long as the activating black-light source is directed at the pigment. The fluorescent pigments convert the black-light energy into a visible form, with the result that these pigments appear to the eye to glow as long as activation by black light continues.

The pigments used for the interior of fluorescent-type lamps are somewhat different from the luminescent pigments just mentioned, since they are best activated by light of a shorter wave length than the black light referred to.

Fluorescent pigments and dyes find application in the dyeing and printing of fabrics, for theater carpets, for lacquers, for markings required to be visible in the dark, and for luminescent printing inks. The color range of luminescent materials includes yellow, orange, red, blue, green, and violet, as well as intermediate colors obtainable by combinations. Luminescent materials in the form of tape or paint have been used for signs, theater exits, ship markings, etc. Still another application is the impregnation of a transparent plastic with luminescent dye or pigment, coating the surface with an opaque finish and then engraving through the opaque finish to form letters that glow under the ultraviolet light.

BLACK FINISHES

Due to war requirements there has been a great extension of the use of black finishes on metals in the last few years. Most of the technique is old but there have been some new developments, particularly in the matter of black nickel plating, which is attained by the use of special plating baths usually containing arsenic and cyanides. The demand for black finishes, combined with the critical shortage of conventional plating materials, has resulted in great expansion in the use of black-oxide finishes obtained by immersing clean steel in hot alkaline baths usually consisting of solutions of sodium and potassium hydroxides, nitrites, and nitrates at temperatures of around 280–300 F, depending upon the solution. These black-oxide coatings produce a fine appearance but are of limited value as protection against corrosion. Penetration of the metal by the black-oxide coating extends to a depth of about 30 to 40 microinches. Because of the thin coating and its distinct color, the proposal has been made that this type of coating might be used on gages where the wearing of the surface would be clearly indicated by a distinct change in color before the gage had worn sufficiently

to affect its accuracy. A method of blackening stainless steel of the "18-8" or "straight-chromium" types has also been reported. This method utilizes a 15 to 20-min dip in sodium dichromate at 730 to 750 F.

ELECTROPLATING OF NONCONDUCTIVE MATERIALS

Although nonconductive materials have been "metallized" by the Schoup spraying process for years, it is only within recent years that success has been attained in electroplating these materials with any degree of adhesion. This process is covered by two U. S. Patents (2,214,646, issued September 10, 1940, and 2,303,871 issued December 1, 1942) and is being exploited by the Metaplast Corporation of New York.

The process is essentially one of removing any polish, cleaning, treating with stannous chloride for $\frac{1}{2}$ to 1 hr to prepare the surface, treating the surface with ammoniacal silver nitrate to precipitate a film of silver to provide the base, and then electroplating in the usual manner. There are, however, some variations of the basic process to meet the conditions created by some materials. The process can be applied successfully to practically any nonconductor providing that it (*a*) does not absorb the solutions, and (*b*) is not too soft to provide a "core" for the shell of plate. It is exceptionally well suited for use with most plastics. Plating can be done with any metal that is capable of being plated by ordinary methods. Adhesion is very good and it is claimed that a force of about 500 psi is necessary to separate the plate from the base, subject to variation dependent upon the base material and the kind of metal. The plated sheet, itself, has good physical characteristics, copper showing a tensile strength of 40,000 to 50,000 psi. The process is quite new, having been in commercial operation for only about 4 to 5 years but it has already been applied to:

(*a*) Decorative pieces such as ornamental plastic "hardware."
(*b*) Slip rings, commutators, and other "insert" type conductors. (These are made by plating into grooves and grinding off the surplus material to leave only that in the groove.)
(*c*) Shielding, such as of loop antennae.
(*d*) Electric outlet boxes of plastic for use in aircraft.
(*e*) Surfacing of plastics to distribute local heating.
(*f*) For reducing warpage of plastics, etc.

ELECTROPOLISHING

Electropolishing originated as a laboratory technique employed in the examination of metallurgical specimens. In the last 5 years it has expanded to a commercial production operation designed to provide a bright decorative surface, to improve the adherence of plate or enamel on base metals, to deburr, descale, improve the microinch finish on surfaces; and to reduce parts to specific dimensions or weights. It is applicable to stainless steels, high- and low-carbon steels, nickel, monel metal, copper, brass, aluminum, and nickel-silver. The process is substantially one of "deplating," the pieces to be polished being placed in the plating bath but connected in reverse directions so that the work becomes the anode rather than the cathode. Current densities and voltages are in the general order of those used in chromium-plating. Considerable research has been done to make the process commercially feasible, and a number of production installations are now in service.

The process is capable of producing a mirror finish on most materials when the original surface is relatively smooth. However, it also produces a bright finish on rough surfaces such as are found on stainless-steel sand castings. It is used as a preliminary operation to reduce the wheel work on some parts which are given a final finish by a wheel buff. Excellent results have been achieved in polishing irregularly shaped objects whose surfaces are difficult to reach with ordinary equipment, and in applications where descaling, deburring, and bright finishing can be combined in a single operation. The process has been used effectively in polishing nickel-plated products which require a lustrous finish.

The time of treatment required varies with the condition of the original surface and the final finish desired. It may range between 1 and 20 min. The amount of metal removed can be controlled precisely and may vary between 0.0001 in. up to 0.002 in. of metal. There are definite limitations as well as advantages to the process and each potential application requires individual study. Best economic results may be obtained with the process being used independently or in combination with other finishing methods. Variations in the finish from a bright mirror-like surface to a soft satin finish may be secured by adequate controls over the operation. Two-tone effects can also be produced.

APPLICATIONS OF SUPERSONIC VIBRATION

Investigation of the effects of supersonic vibrations has resulted in some interesting developments. One of these is the tin-plating of aluminum which has been successfully accomplished in Germany. As is well known, aluminum is one of the numerous metals which quickly form a surface coat of oxide film. This film has the advantage of tending to increase corrosion resistance, but it interferes considerably with efforts to plate the aluminum. Investigation showed that vibration at a frequency above that of sound has the effect of practically shaking off this oxide film, thus providing a clean surface to facilitate union with another metal. This is being applied to the tin-plating of aluminum sheet in Germany by dipping aluminum in molten tin while subjecting it to vibrations of the order of 12,000 or more cycles per sec. This compares with 20 to about 16,000 cycles per sec for the extreme range of human hearing. The effect is to remove the oxide film and to cause the tin to leave a firmly bonded coating on the aluminum.

Another application of supersonic vibration has been found in the ability to produce extremely finely dispersed solid particles in liquids, thus offering tremendous possibilities in the way of producing mixtures or materials that are normally immiscible. This method has already been used in Germany to produce a bronze containing 25 per cent of graphite. Still another application of supersonic vibration has been found in the destruction of some forms of germ life. This, however, is still in the embryonic stage.

The supersonic waves are produced by electronic means; a current is produced having a frequency equal to that of the vibrations required. This current is then used to produce the supersonic vibrations by use of the magnetic field.

MACHINABILITY STUDIES

Despite the importance of the subject of machinability, there was no concerted effort made to reduce the information to a common denominator until 1937, when the "Independent Research Committee on Cutting Fluids" was organized by Joseph Geschelin, Detroit editor for *Automotive & Aviation Industries*. This committee made public its initial report in 1940. Some revisions and amplifications were made subsequently, the latest appearing in 1943. Starting with B-1112 steel as 100 per cent, this report groups all metals into six classes as shown in Table 13.

The metals already investigated cover a wide range and include all of the materials most generally used. The report covers not only rating as to machinability but also makes recom-

TABLE 13 MACHINABILITY GROUPS

Class 1 Ferrous,	Rating over 70 per cent[a]
Class 2 Ferrous,	Rating 50 to 70 per cent
Class 3 Ferrous,	Rating 40 to 50 per cent
Class 4 Ferrous,	Rating below 40 per cent
Class 5 Nonferrous,	Rating over 100 per cent
Class 6 Nonferrous,	Rating below 100 per cent

[a] As compared with A.I.S.I. B-1112 cold drawn.

mendations as to cutting fluids based upon the machinability rating and the type of metal. Machinability is based upon compilation and averaging of estimates of users, ratings being taken as the nearest 5 per cent. Since the tables would take up appreciable space and would be incomplete without the supplemental text, instead of including them here, reference is made to the original publication (see Bibliography[1]).

DAMPING PROPERTIES OF ENGINEERING MATERIALS

Although information on the damping properties of rubber has been available for many years in fairly complete forms, this type of information on other materials has been extremely limited. Some investigations made in England in recent years have added much to our knowledge of this subject. In general, it was found that all steels (carbon and various alloys) had relatively low damping capacity although considerable variation existed between one composition and another and some "stainless" irons showed up well. Sintered carbides, plate glass, and alloys of aluminum, magnesium, copper-zinc, and copper-tin showed relatively low values for the compositions tested. Highest values were shown by cast irons, lead, solder, commercial nickel, cellulose nitrate, and the phenol resins. The most important result derived from the investigation is probably the conclusion that (where subjected to alternating stresses) material with a low fatigue strength and high damping capacity may outlast material with high fatigue strength and low damping capacity. Another important conclusion is that the damping capacity of a material must be considerable in order to affect the frequency of vibration transmitted.

REFRACTORY MATERIALS

Among the developments in refractory materials is the application of silicon carbide (originally developed as an abrasive) to this purpose. Because of its high decomposition point and its immunity to ill effects from high temperatures, it is well adapted to this purpose. This material is being used as a refractory in the form of bricks and special formed shapes. For exposure to very high temperatures the three synthetic compounds, given in Table 14, are now available, although only the first two have been used for this purpose.

TABLE 14 APPROXIMATE MELTING POINT OF SOME REFRACTORIES

Material	Melting point, Deg F	Melting point, Deg C
Silicon carbide (SiC)	4200[a]	2300[a]
Aluminum oxide (Al_2O_3)	3722	2050
Boron carbide (B_4C)	4440	2427

[a] Decomposes.

In addition to its uses as an abrasive and refractory material, fused aluminum oxide in extremely fine size grains (about 7 to 8 microns) is used as a coating for the heating element in radio tubes to increase the emission at low temperatures.

HARDNESS-TENSILE STRENGTH CONVERSION TABLES FOR METALS

During the last several years a number of tables and charts have been published on the matter of converting hardness readings to ultimate tensile strength for various metals. This work began in earnest with the extensive research of Howard Scott and T. H. Gray of the Westinghouse Electric & Manufacturing Company, and their charts have been widely used. Shortly after the appearance of these charts for steel, others followed for various nonferrous metals. These tables and charts have proved to be very useful in providing nondestructive checks of tensile strength by inspection departments and for checking heat-treatment, as well as segregating materials that have become mixed in stock. However, the relationship of hardness readings to tensile strength is subject to many factors that influence the ratio of the two values. When such tables or charts are used, they must be considered as subject to certain limitations, the more important considerations being as follows:

1 The conversion table used must be (within reasonable limits) for the type of composition to which it is applied.

2 Conversions cannot be relied upon if the material is less than a certain minimum thickness.

3 Hardness readings cannot be relied upon to give an accurate estimate of the tensile strength of a hardened "case."

4 In some instances, particularly with the softer metals which are normally hardened by cold-working, erratic results indicate that the physical condition of the metal has an influence on the hardness-tensile-strength relationship.

Surface hardening as a result of machining, grinding, or polishing may also affect the relationship if any of the superficial hardness readings are used. Due to all of these factors, some investigators have advised that the user create his own conversion table to insure its application to the material for which he expects to use it.

DOUBLE-WALL TUBING

An original method of producing steel tube was introduced by the Bundy Tubing Company in 1931 but did not attain substantial production until about 1935. This method utilizes steel strip which has been copper-coated. The strip is rolled twice around a steel mandrel to form a tube and the rolled tube is then passed through a brazing furnace where the overlapping plies and the inner and outer seams are brazed by fusion of the copper. The resulting product is a double-wall steel tube which is copper-brazed throughout and can be formed as readily as a seamless tube. This tube is also available with a solder coating on the outside. Monel tube is now made by substantially the same method, this type having been added in 1940–1941.

CORRONIZING

A process of metal-coating for corrosion prevention, which was developed in 1939, is now being marketed by the Standard Steel Spring Company of Coraopolis, Pa., under the trade name of "Corronizing." This process consists of electroplating ferrous or nonferrous metals with thin layers of nickel and zinc and then subjecting the coated metal to a suitable heat-treatment. The two metals become fused together, forming several nickel-zinc alloys in layers; these alloys possess high corrosion resistance as a result of which the protection exceeds that attainable with either nickel or zinc alone. Corronized metal can be formed, drawn, welded, soldered, sheared, blanked, pierced, or embossed without material loss of rust resistance. The coating has a semilustrous gun-metal finish, does not "flour" when exposed to atmospheric corrosion, and also provides a good adherent surface for paints or enamels. The tests of this finish show that steel sheet with a corronized surface will withstand the salt-spray test as well as a zinc coating of 5 to 10 times the thickness.

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465 "New Study of Cutting-Fluid Recommendations," by H. L. Moir and O. W. Boston, S.A.E. Nat. Production Meeting, May, 1940.
466 "Machinability Ratings of Metals and Cutting-Fluid Recommendations," by O. W. Boston, H. L. Moir, W. H. Oldacre, and E. M. Slaughter, *Metal Progress*, Oct., 1943, pp. 622–624A.
467 "Effect of Structure and Composition on the Machinability of Copper Alloys," by D. K. Crampton, *Metal Progress*, Aug., 1944.
468 "Machinability Ratings of Metals and Cutting Fluid Recommendations," by O. W. Boston, H. L. Moir, W. D. Oldacre, and B. M. Slaughter (revision of 1943 report; available from the Committee).

DAMPING PROPERTIES OF ENGINEERING MATERIALS

469 "The Damping Capacity of Engineering Materials," by W. H. Hatfield, G. Stanfield, and L. Rotherham, Trans. North East Coast Institution of Engineers and Shipbuilders, England, vol. 58, 1942.
470 "The Damping Capacity of Engineering Materials" (digest of ref. 469), *Metals and Alloys*, June, 1944, pp. 1435 and 1437.

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471 "Silicon Carbide Linings in Water Gas Generator," by T. F. Paper, *American Gas Journal*, Oct., 1943.
472 "The Construction of Electric Furnaces for the Laboratory," publication of Norton Company, Worcester, Mass., Oct., 1942.
473 "Abrasives in the Role of Super-Refractories," by H. C. Fisher, *Metal Progress*, Aug., 1941 (lists abrasives applied to refractory uses and compares their properties).

HARDNESS-TENSILE STRENGTH CONVERSION TABLES FOR METALS

474 "Hardness Conversion for Hardened Steels," by Howard Scott and T. H. Gray, *Metal Progress*, Oct., 1941, p. 524 (also, *Metal Progress*, March, 1944, p. 502B).
475 "Hardness Conversion Chart for Cartridge Brass (70% Cu 30% Zn)," *Metal Progress*, Feb., 1943, p. 235, and Oct., 1943, p. 714.
476 "Cartridge Brass," by L. E. Gibbs, *Metal Progress*, June, 1943, p. 897, and Aug., 1943, p. 243 (includes curves of hardness and tensile strength for brass).
477 "Hardness of Aluminum Sheet," by R. L. Templin, *Metal Progress*, July, 1943, p. 86.
478 "Engineering Properties of Monel," *Metal Progress*, Oct., 1943, p. 710 (includes some hardness-strength data).
479 "Engineering Properties of 'A' Nickel," *Metal Progress*, Oct., 1943, p. 711 (includes some hardness-strength data).
480 "Hardness Conversion Chart for Steels," *Metal Progress*, Oct., 1943, p. 852.
481 "Magnesium Alloys," *Metal Progress*, Oct., 1943, p. 704 (includes some hardness-strength data).
482 "Properties of Important Wrought Chromium-Nickel-Iron Alloys," *Metal Progress*, Oct., 1943, p. 690 (includes some hardness-strength data).
483 "Alcoa Aluminum and Its Alloys," Aluminum Company of America, Pittsburgh, Pa., 1944 (includes some hardness-strength data).

DOUBLE-WALL TUBING

484 "Bundyweld Tubing," publication of Bundy Tubing Company, Detroit, Mich., 1944.

CORRONIZING

485 "Corronizing," leaflet published by Standard Steel Spring Company, Coraopolis, Pa.

A MESSAGE *to* EACH ENGINEER *from the* CHAIRMAN *of* E.C.P.D.

By EVERETT S. LEE

CHAIRMAN, E.C.P.D. MEMBER A.S.M.E.

THE semi-annual meetings of the Engineers' Council for Professional Development have just been completed and I hasten to tell you of the work. I am sure you will be pleased with the progress for good, even in these busy times of high pressure of war-production work in which the engineers are so effectively engaged.

SELECTION AND GUIDANCE PROGRESSING

Committee chairmen met the first day of a two-day meeting March 13 and 14, 1945. A. R. Cullimore, chairman of the Committee on Student Selection and Guidance, presented his report of full activity. Work in guiding returning veterans is in substantial progress. Though there are many agencies engaged therein, President Cullimore's committee feels that fully 75 per cent of this work in community projects is done by high-school people. Thus our efforts as in the past, for young engineering students, will be continued through the high schools. This will be of particular interest to local co-ordinated engineering councils to progress this work effectively. To this end President Cullimore asked approval to print 25,000 more copies of "Engineering as a Career." In this connection it may interest you to know that the score on "Engineering as a Career" is:

First publication	1942
Total number printed	60,000
Total number sold	43,000
Total number given free distribution	7,000
Balance on hand	10,000

Also, we have a balance of $1600 in the account from which we are taking $1050 to print the additional 25,000 copies. These results are surely an outstanding tribute to the usefulness of this worthy book and I call to the attention of all of our members the opportunity existing for them to participate in the guidance work to such great advantage.

The second of President Cullimore's projects is that of measurement and guidance in engineering education which is being directed by Dr. K. W. Vaughn of the Carnegie Foundation. This work promises to give us test data for the evaluation of the engineering student. The initial test results from some 10,000 engineering students entering 26 collegiate schools will be the subject of a report to be issued soon. E.C.P.D. is proud to have been instrumental in starting this work. It is also proud that it will be associated with this project in the future, as it should have lasting benefits comparable with those already attained.

WORK OF ACCREDITING EXPANDED

D. B. Prentice reported for the Committee on Engineering Schools. This committee is responsible for the accrediting of collegiate curricula and its contributions throughout these last twelve years has been substantial. Now, following its request, the committee has set itself up to accredit technical institutes. This work has now started. We in E.C.P.D. feel that with the growing opportunity of the technical institute the accrediting program will provide the basis of an orderly evaluation of the place of the technical-institute graduate. This is of fundamental importance to the engineering profession.

Dr. Prentice also reported that the "Guide" for academic credits for war-connected educational experience was in circulation and that it had been a great success. The Guide makes possible an evaluation for credit of the many courses given during these war years. The magnitude of this project was enormous. Under the auspices of the American Council on Education, E.C.P.D. contributed both in material and in means. We are proud to have been associated with this worthy enterprise.

You are all interested in the status of the engineering schools today. The last paragraph of Dr. Prentice's report is most interesting. I am quoting it completely:

> Enrollments at engineering colleges are very low, not over a third, counting freshmen, of five years ago. Nearly sixty per cent of the students are freshmen so that above this class, present enrollment is approximately twenty per cent of prewar, with senior class registration down to one sixth. In spite of this condition, most engineering schools are carrying on their programs with little reduction from normal. Smaller classes will more than offset other disadvantages so that graduates of these years, it is believed, will be as well trained as under ordinary conditions.

This is a statement to bring hope to you in spite of dire conditions. And until college graduates are again entering our profession normally, the load usually carried by the younger engineers will have to be carried by the returning veterans. This is a logical situation which we can make as effective as the normal situation if we give our attention to it.

JUNIOR READING LIST REVISED

Dr. Pohl's report for the Committee on Professional Training told of the Junior Reading List which has been prepared. A large edition has been printed. You can obtain a copy from E.C.P.D. at a nominal charge. You will want a copy.

We are all looking forward with great interest to the E.C.P.D. Manual for Junior Engineers which W. E. Wickenden is writing for us. This will be the Engineer's Handbook of the Engineering Profession. In the hands of the student, the professor, and the employer in industry it will give a co-ordinated picture of the engineering profession and the part each engineer plays in it. This is one of our future gems, and you will hear much more of it in the days to come.

SCOTT'S WORK BEING CARRIED FORWARD

Dean Dougherty could not be present to give the report of the Committee on Professional Recognition but the report of the committee was presented by George A. Stetson. This committee was previously under the chairmanship of Charles F. Scott, beloved of all engineers. His death last fall took from us a great friend. His presence everywhere brought enthusiasm for the engineer and the engineering profession. Dean Dougherty's committee plans to continue the work which Dr. Scott pressed forward with such vigor.

COLLECTIVE BARGAINING FOR ENGINEERS DESERVES CAREFUL STUDY

V. T. Boughton reported for the Committee on Employment Conditions for Engineers. His report is a résumé of the actions in the respective societies. As these have been printed in the

societies' journals they are familiar to you. I will not repeat them. But I will say this. Wherever I go engineers ask me what stand E.C.P.D. has taken on collective bargaining. The answer is, E.C.P.D. has not taken action on this subject. When I am asked my thoughts, I say, I trust each engineer will study to the very end the ramifications of collective bargaining and all that it entails and all that it involves before he enters it from his accustomed position of freedom of action. If he finds it advantageous and worth the amount of freedom he gives up together with the complexity he assumes by entering therein, why, well and good, but it is my firm conviction from study and thought that he will be in infinitely better position if he puts his energies into bringing about a realization of the true position of the engineer and of the engineering profession so that he will enjoy the freedom which is rightfully his by reason of the fundamentality of his contributions. The engineer has a most convincing statement to make of his position. Let him make it with conviction and with courage. I am confident he will be accorded the place which the profession justifies. May the engineer look upward to better ways.

"FAITH OF THE ENGINEER" WIDELY ACCLAIMED

Dr. Jackson reported for the Committee on Principles of Engineering Ethics that the work of writing a Canon is progressing. The "Faith of the Engineer" published last year has been most enthusiastically received. I repeat it here:

FAITH OF THE ENGINEER

I am an Engineer. In my profession I take deep pride, but without vainglory; to it I owe solemn obligations that I am eager to fulfill.

As an Engineer, I will participate in none but honest enterprise. To him that has engaged my services, as employer or client, I will give the utmost of performance and fidelity.

When needed, my skill and knowledge shall be given without reservation for the public good. From special capacity springs the obligation to use it well in the service of humanity; and I accept the challenge that this implies.

Jealous of the high repute of my calling, I will strive to protect the interests and the good name of any engineer that I know to be deserving, but I will not shrink, should duty dictate, from disclosing the truth regarding anyone that, by unscrupulous act, has shown himself unworthy of the profession.

Since the Age of Stone, human progress has been conditioned by the genius of my professional forebears. By them have been rendered usable to mankind Nature's vast resources of material and energy. By them have been vitalized and turned to practical account the principles of science and the revelations of technology. Except for this heritage of accumulated experience, my efforts would be feeble. I dedicate myself to the dissemination of engineering knowledge, and, especially, to the instruction of younger members of my profession in all its arts and traditions.

To my fellows I pledge, in the same full measure I ask of them, integrity and fair dealing, tolerance and respect, and devotion to the standards and the dignity of our profession; with the consciousness, always, that our special expertness carries with it the obligation to serve humanity with complete sincerity.

E.C.P.D. REPRESENTED ON CITIZENS' FEDERAL COMMITTEE ON EDUCATION

The second day of the meeting was reserved for the Executive Committee of the Council. The necessary routines of committee appointments were accomplished. The reports of the committees of the previous day were studied and accepted. A budget was adopted. This was for some $18,000. The work for the next six months and plans for the year were established.

You will be interested particularly in some of the actions. The Consultative Committee on Engineering to the War Manpower Commission was appointed by Mr. McNutt in the fall of 1943. We appeared in Washington to plead for the engineer. We showed that the needs of the nation demanded that the engineer be continued in his collegiate training and in industry. We did not get all we asked, but we were told that we did bring a picture of the engineer and his contributions to the war which was received with favor and regard. And now Mr. McNutt has asked that the Engineers' Council for Professional Development appoint a representative to the Citizens' Federal Committee on Education which he is setting up in the Federal Security Agency. The other two professions so recognized are the American Medical Association and the American Bar Association. So the engineers have been honored. I well remember hearing many times my engineering associates ask, "Why do we not have recognition such as is accorded the doctors and the lawyers?" I say we have it and we can continue to have it if the engineers will give some of their time to the doing of these things. This is important and it must be progressed with vigor. This is a necessary part of recognition and the more it is recognized and practiced the greater will be the participation of the engineers therein. This is a condition which engineers must recognize if they are to have accrue to themselves the position for which they are eager.

And yet we do have that position by virtue of the accomplishments of those who have preceded us and who have given of their time and thought and energies to these things. Let each engineer ask himself how much time he has given or is giving to the progression of the engineering profession. If it is meager, then there is still time for him to do more.

To this end the Engineers' Council for Professional Development has written and issued the pamphlet, "Will You Help?" I wish every engineer might have it. If you will write to E.C.P.D. for it we will send you a copy free.[1] It will tell you how to work through your professional engineering society, branch, section, or chapter to bring about a greater recognition of the engineering profession. Particularly can this be done through the local co-ordinated engineering councils. These are located throughout the land. We are sending a copy of the Twelfth Annual Report of E.C.P.D. for the year 1944 to each of seventy of these local engineering councils. This will give every engineer who belongs to a member society, and to those societies associated with the member societies, the opportunity to make a contribution to this work.

I call upon each engineer to give thought and study and time to the opportunity through the E.C.P.D. for the advancement of the profession. Will You Help!

* * * * *

I have written this message just as though each engineer knows what E.C.P.D. is and what it is doing. In the event you do not know of E.C.P.D. I will say it is a conference organized to enhance the professional status of the engineer through the co-operative efforts of the following national organizations, concerned with the professional, technical, educational, and legislative phases of engineers' lives:

American Society of Civil Engineers
American Institute of Mining and Metallurgical Engineers
The American Society of Mechanical Engineers
American Institute of Electrical Engineers
The Engineering Institute of Canada
The Society for the Promotion of Engineering Education
American Institute of Chemical Engineers
National Council of State Boards of Engineering Examiners

E.C.P.D. operates by developing procedures to be recommended to the sponsoring organizations and by administering such procedures as are approved, functioning through standing committees on Student Selection and Guidance, Engineering Schools, Professional Training, and Professional Recognition, or through such new committees as may be established.

[1] Questions regarding E.C.P.D. and requests for its publications should be addressed to Engineers' Council for Professional Development, 29 West 39th St., New York 18, N. Y., and in Canada to The Engineering Institute of Canada, 2050 Mansfield St., Montreal, Canada.

A.S.M.E. BOILER CODE

Interpretations

CASE No. 983

(Annulled)

CASE No. 983, as formulated at the March, 1943, meeting of the Boiler Code Committee, permitted an extension of the tables of allowable working stresses by allowing other grades of bolting material.

The Boiler Code Committee, at its March, 1945, meeting, took action to annul this Case for the following reasons: (1) Since the issuance of the Case, item (1) covering heat-treated carbon bolts was annulled as a result of the adoption of Specification SA-261; (2) manganese steel was originally proposed to conserve the use of alloy steel. It has not been made available for use and since the low alloy NE steels are now generally available, provisions for its use could now be omitted; (3) all the NE steels referred to in this Case have been discontinued. Since available NE steels may be furnished to Specification SA-96, there would be no need for the retention of reference to any NE steels in the Case.

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., so that they may be presented to the Committee for consideration.

PAR. P-268(**r**) AND U-59(**s**). Add the following:

When inward projecting edges of nozzle or manhole necks are to remain unwelded in the completed vessel, these edges shall not be cut by shearing unless at least $^1/_8$ in. of additional metal is removed by any method that will produce a smooth finish.

TABLE P-6. Omit allowable working stresses for Specification SB-178.

TABLE A-8. To make this table agree with the American Standard for Cast-Iron Pipe Flanges and Flanged Fittings, Class 250 (ASA B16b–1944), change as follows: Correct values to agree with Table 2 of B16b–1944; omit columns for "total effective bolt area" and "stress, lb per sq in. bolt metal;" omit values of "metal thickness of body" for sizes up to 2 in., and "face-to-face dimensions of length of tee" up to 2 in., correcting the remaining values to agree with Table 4 of B16b–1944; correct notes under Table to agree with B16b–1944; add notes covering sections 4 and 6 of Par. 8, Bolting, of B16b–1944; include column "length of bolts;" the reference to the Standard in the title to be changed to "Class 250;" add a footnote under the table of dimensions reading the same as Par. 1, Pressure Rating, of the introductory notes to the Standard, omitting the reference to rating "at or near the ordinary range of air temperature" for boiler use, but include this reference in Tables UA-3 and UA-4.

TABLE A-7. Change title for "125 lb" to "Class 125," include as a footnote Par. 1, Pressure Rating, of the introductory notes to the Standard, omitting the ratings "at or near the ordinary range of air temperature."

PAR. P-299(**c**). Reference should be to American Standard for 100 lb instead of 125 lb, and "pressure ratings of 100 lb or more" instead of "125 lb."

PAR. P-302. "Shall be at least equal to the American Standard for 100 lb pressure" instead of "125 lb." "Valve and fittings pressure rating of 100 lb pressure or more" instead of "125 lb."

PAR. H 14(**a**). Revise to read as follows:

(**a**) The minimum thickness of STEEL OR WROUGHT IRON tubes used in water-tube or fire-tube boilers [measured by Birmingham wire gage] shall be as given in Table H-3.

TABLE H-3. Omit the term "Bwg" from the heading of the last column, and change the following in the body of the column: Change No. 13 to 0.095 in., No. 12 to 0.105 in., No. 11 to 0.120 in., No. 10 to 0.135 in., and No. 9 to 0.150 in.

PAR. U-59(**h**). Add the following as (3):

(3) The minimum size of attachment welds for threaded connections of which some acceptable designs are shown in Fig. U-10(**t**) to (**w**), inclusive, need not conform to the minimum values under this Figure, but shall conform to Par. U-59(**g**).

PAR. U-59(**o**). Add the following:

When nozzles or couplings are attached to drums, shells or headers of unfired pressure vessels as shown in Fig. U-10(**b**) and (**d**), and are welded from one side only, backing strips must be used except:

(1) When the wall thickness to which the nozzle or coupling is attached is not greater than $^3/_8$ in.;

(2) When the inside of the joint can be visually inspected so that the inspector may satisfy himself that complete penetration is obtained.

PAR. U-66. Revise (**a**) to read:

(**a**) The manufacturer shall stamp each pressure vessel constructed in compliance with the Code in the presence of the inspector, after the hydrostatic test, in the shop of the manufacturer, except that in cases where pressure parts cannot be completed and hydrostatically tested before shipment, proper stamping as called for in (**f**) shall be applied at the shop and the data sheets signed by the same or different inspectors who shall indicate the portions of the inspections made at the shop and in the field. The stamping on the vessel shall consist of the A.S.M.E. Code symbol (shown in Fig. U-12), the manufacturer's name, the manufacturer's serial number, the working pressure, and the year built, denoting that the vessel was constructed in accordance therewith. The maximum temperature corresponding with the maximum allowable working pressure shall also be stamped on the vessel.

PAR. U-66. Insert the following as (**f**):

(**f**) When only a "part" of an unfired pressure vessel is supplied and the data are recorded on manufacturers' data report form U-2 (See Par. U-65**c**), unless otherwise specified, it shall be stamped with:

(1) A.S.M.E. Code symbol and underneath the symbol the word "part,"
(2) Name of manufacturer,
(3) Manufacturer's A.S.M.E. serial number of that "part,"
(4) Maximum allowable working pressure,
(5) Year built.

This does not apply to such parts as handhole covers, manhole covers or their parts.

PAR. U-66. Add the following as (**j**):

(**j**) Vessels built under the rules of Pars. U-140 to U-144 shall be stamped also with the lowest permissible temperature. If the required stamping is to be directly on the special seamless type of vessels, it shall be applied only to some thickened or reinforced portion of the vessel.

PARS. U-78(**g**) and U-208(**c**). Revise items (1) and (2) as follows:

(1) When THE WIDTH OF ANY SINGLE [there is] slag inclusion between layers OF WELD METAL substantially parallel with the plate surface [and which] is not GREATER [more] than one half the width of the weld metal WHERE THE SLAG INCLUSION IS LOCATED;

(2) When THE TOTAL THICKNESS OF ALL OF THE [there is] slag inclusions [across the thickness of] IN ANY PLANE AT APPROXIMATELY RIGHT ANGLES TO the plate SURFACE IS NOT GREATER [more] than 10 per cent of the thickness of the thinner plate.

PAR. U-140 to U-144. Revise as follows:

These rules cover the additional requirements for vessels intended for use at temperatures below −20 F in which region many of the materials acceptable for service at normal temperatures suffer such loss of impact resistance as to become unable to safely resist shock or sudden changes of stress

or stresses at points of high-stress concentration. They cover vessels for use with any liquid or gas under the limitations of other sections of the Code.

U-140 Materials. (a) Materials shall conform to the specifications given in Par. U-13, or in this paragraph. If the vessels are fabricated by fusion-welding, the materials, if ferrous, shall conform to the specifications given in Par. U-71; if nonferrous, with Specification SB-96 or SB-98 for copper silicon alloys, SB-127 for monel metal, SB-111 for cupro-nickel, SB-11, SB-13, SB-42, SB-75, or SB-111 for copper. (See footnote under Par. U-71 referring to stainless steel material. For welding of copper silicon alloys see Case No. 864, for monel metal Case No. 935, and for copper Case No. 934.)

(b) Seamless materials conforming to Specification SA-53, with the following additional requirements as to tensile properties, may be used for the manufacture of special seamless containers under the design limitations given in Par. U-141(b):

Minimum tensile strength, psi	Elongation in 2 in., per cent
62,000	25
75,000	22½
90,000	18

(c) All materials shall meet the impact test requirements of Par. U-142. If welded, the deposited weld metal and the heat affected zone shall also meet the impact test requirements of Par. U-142.

U-141 Design. (a) The design and construction of vessels to operate at low temperature shall conform to the rules of this Code that are applicable to the type of fabrication used. If of welded construction, they shall conform to the requirements for welding given in Par. U-68 or U-69, or in Par. U-200 or U-201.

(b) Design stresses of one-quarter the minimum tensile strengths specified in Par. U-140(b) for SA-53 material may be used for special seamless containers, provided the following additional requirements are met:

(1) The vessels are seamless with no holes except as herein provided;

(2) The end or head to which any attachments are made are thicker than the shell portion;

(3) The thickness of the vessel is gradually increased near the head to minimize stress concentrations;

(4) Outlet openings are not to exceed ¾ in. standard pipe size and are to be placed in the thickened part at or near the head at a point where the calculated stress, without holes, is not more than one half of the maximum allowable stress.

(5) No welding is utilized.

Two acceptable forms for the special containers covered by this paragraph are shown in Fig. U-30.

U-142 Impact Tests. (a) Impact tests shall be made at the lowest temperature of operation except that when the vessel will operate at a pressure not in excess of one half the maximum allowable working pressure when at the lowest temperature due either to the properties of the contents or to the cycle of operation employed, the impact requirements shall be met for the temperature at which the operating pressure equals more than one half the maximum allowable working pressure.

(b) Number of Tests. (1) For each pressure vessel there shall be made one complete series of impact tests from each heat of material used for shell, heads, nozzles, or other pressure part in the assembly, except that no impact test is required for material to be used for nozzles, flanges, or covers having a thickness less than 0.098 in., or for openings that do not require reinforcement in accordance with Par. U-59. Each complete series of impact tests shall consist of three specimens. If vessels are of welded construction, test plates similar to those required by Par. U-68 shall be made of one of the same heats of material as used in the vessel. One set of impact bars shall be taken across the weld with the notch in the weld metal and one set shall be similarly taken with the notch in the adjacent metal in the heat-affected zone.

(2) For small vessels coming within the size defined by items (1) and (2) of Par. U-1(a), one impact-test series may represent each lot of 100 vessels or less, from each heat of steel. Certified reports of impact test series by the material producer will be acceptable evidence provided the material is not subjected to treatment during or following fabrication that will alter its impact resistance; if such treatment is subsequently applied to the material, the impact test must be so made as to be representative of the condition in which the material will be used. If the vessel be heat-treated, each heat-treatment batch shall be considered a "lot."

(c) Temperatures of Tests. Impact-test specimens shall be cooled to the temperature required for the test specified in (a) of this paragraph at which the vessel is to be operated. The specimens shall be uniformly cooled by subjecting them to the test temperature for at least 30 min and the handling tong shall be cooled similarly. The test shall be made within 8 sec after removal from the cooling medium.

(d) Test Specimens. The impact test specimens shall be of the Charpy type, as illustrated in Fig. U-31 or of the Izod type as illustrated in Fig. U-32. The standard 10 mm × 10 mm specimen shall be used where the thickness is 7/16 in. or greater and, for thinner material, a similar specimen shall be used, except that the dimension along the axis of the notch shall be reduced from 10 mm to the largest possible of 7.5 mm, 5 mm, or 2.5. The length of the impact bar shall, wherever possible, be taken parallel to the direction of the expected maximum stress. The required impact-test bars for special seamless vessels may be taken from the end before the shell is thickened for closure.

(e) Impact Test Requirements. The impact properties shall conform to the following:

Impact specimen, Keyhole, ~~Equivalent~~ Notch, or V-Notch	Min impact value, ft-lb at min operating temperatures
10 mm × 10 mm	15

(NOTE: Provision for reduced width specimens has been deleted upon recommendation of a special committee investigating the subject. Discussion thereon is invited.)

(f) The results of the three specimens of a complete series shall be averaged. When an erratic result with widely varying values indicates a defective specimen, a retest will be allowed.

(g) Heat-Treatment of Test Bars. All tests are to be run on bars in the equivalent section and treated in exactly the same manner as are the vessels. If the vessels are to be heat treated, the bars shall be heat-treated before machining.

U-143. (Omit any special reference to Safety Devices in these Rules.)

U-144. (Omit present paragraph, the text of which is transferred to Par. U-66.)

PAR. U-208(d). Add the following to the first section:

Any spot examined by this method may coincidentally represent, one procedure, one operator, and one interval of 50 ft of joint length.

PAR. U-208(e)(2). Insert the following as the first sentence:

Welds in which the radiographs show any type of crack or zones of incomplete penetrations shall be unacceptable.

TABLES UA-3 AND UA-4. To be revised to conform with revised Tables A-7 and A-8.

Manufacturers Data Report for Unfired Pressure Vessels. Revise item 20 to read:

20 Nonpressure parts. (*a*) Supporting lugs, No.... Supporting skirts.... (*b*) Other nonpressure parts. Kind and number.... (*c*) Where and how attached.....

Section II of the Code. Specification SA-18 will be dropped from the Code.

To make Code specifications identical with the latest A.S.T.M. specifications, they will be revised as follows (a complete copy of the text of the revisions may be obtained upon application to the Secretary of the Boiler Code Committee):

SA-27, a new Par. 9 will be inserted; SA-30, Par. 14(a); SA-53, Pars. 2(a), 2(b), 4, 14, 15, 17, Tables 1 and 2; SA-70, Par. 15(a); SA-83, Par. 17(a); SA-95, a new Par. 11 will be inserted; SA-96, Par. 14 and Table 2; SA-135, table of tensile requirements in Par. 6(a), Par. 14(a); SA-157, a new Par. 11 will be inserted. SA-158, Tables 1 and 2; SA-178, Par. 18; SA-182, Table 1 and Par. 10; SA-192, Pars. 6 and 17(a); SA-201, Par. 15(a); SA-202, Par. 14(a); SA-203, a new Par. 7(b) will be inserted, Pars. 14(a) and 15(a); SA-206, Table 1; SA-209, Pars. 6(a), 7, 19(a); SA-210, Pars. 6(a), 7, 19(a); SA-212, Par. 14(a); SA-213, Table 2, Pars. 6(a), 7, 19, Table 1; SA-214, Par. 16; SA-216 and SA-217, a new Par. 11 will be inserted; SA-225, Pars. 7 and 14; SA-226, Par. 17(a); SA-240, Table 2, Par. 12; SA-249, Table 1, Par. 19; SA-250, Par. 19; SA-261, Par. 14; SA-263, Table 1, Par. 4(b); SA-266, Par. 14; SB-61, Pars. 1, 4, 6(b); SB-62, Pars. 1, 4, 6(d); SB-98, Table 2; SB-126, Tables 1, 2, Par. 8; SB-178, Tables 1, 2, Par. 8.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. Los Angeles Aviation War Conference to Be Held at University of California at Los Angeles, June 11–14

ENGINEERS in Los Angeles will have an opportunity to attend the A.S.M.E. Los Angeles Aviation War Conference to be held at the University of California at Los Angeles, June 11–14, 1945, under the auspices of the A.S.M.E. Southern California Section.

All sessions commence at 7 p.m. and are to be held in the University buildings. The meeting will be strictly in accordance with the spirit of the present ban on conventions that require hotel accommodations and railroad travel other than by normal local services.

The meeting is a contribution of the A.S.M.E. to the war effort in co-operation with the University of California. No registration fee is required and all sessions are open to the public.

Program of 38 Papers Planned

A program consisting of 16 sessions at which 38 papers are scheduled for presentation has been prepared. The opening session on Monday evening will be held in Royce Hall and will be addressed by Dr. Clarence A. Dykstra, provost of the University of California at Los Angeles. Following this address two papers, each illustrated with motion pictures, will deal with jet propulsion and jet-propelled airplanes.

The session on Tuesday evening will be devoted to papers on heat transfer, standards and quality control, rubber and plastics, instruments and regulators, and applied mechanics. A second heat-transfer session will be held Wednesday evening, simultaneously with sessions on management, production, metals engineering, power plants, and gas turbines and jet propulsion.

The third heat-transfer session is scheduled for Thursday evening, at which time there will also be sessions devoted to production, hydraulics, applied mechanics, and instruments and regulators.

Aviation Meeting Committees

Timothy E. Colvin is general chairman of the committee in charge of the meeting.

Members of the Honorary Advisory Committee are: Hall L. Hibbard, G. A. Huggins, Dr. Robert A. Millikan, Admiral E. M. Pace, R. H. Rice, Dr. Robert G. Sproul, and General D. F. Stace.

T. A. Watson is serving as chairman of the Program Committee. Assisting him are the following committees: *Heat Transfer*, L. M. K. Boelter, H. S. Gordon, W. W. Reaser; *Rubber and Plastics*, John Delmonte; *Production and Tooling*, T. A. Watson, J. C. Dillon, F. R. Adler; *Applied Mechanics*, R. F. Shanley, W. H. Shallenberger, William Schroeder; *Metals Engineering*, William Schroeder, F. R. Adler; *Instruments* and *Regulators*, S. G. Eskin; *Management*, V. L. Peickii, E. H. Farmer; *Hydraulics;* Th. von Kármán, A. Hollander, R. Middleton, Paul Armstrong; *Oil and Gas Power*, W. H. Shallenberger.

The Arrangements Committee consists of Prof. Wendell E. Mason, chairman, Dean L. M. K. Boelter, and Prof. Wesley L. Orr.

Dr. E. O. Bergman is chairman of the Reception Committee. Assisting him are Lieut. W. R. Gould, U.S.N.R., A. R. Weigel, M. L. Crater, B. N. Palm, V. A. Peterson.

The Executive Committee of the Southern California Section is headed by Raymond G. Roshong, chairman.

A. R. Stevenson, Jr., is chairman of the A.S.M.E. Aviation Division; and J. E. Younger, who has spent much time on the Pacific Coast making arrangements for the meeting, is its secretary.

MONDAY, JUNE 11

7:00 p.m.

Gas Turbines and Jet Propulsion I

Royce Hall

Chairman: L. M. K. Boelter, dean of engineering, University of California at Los Angeles.

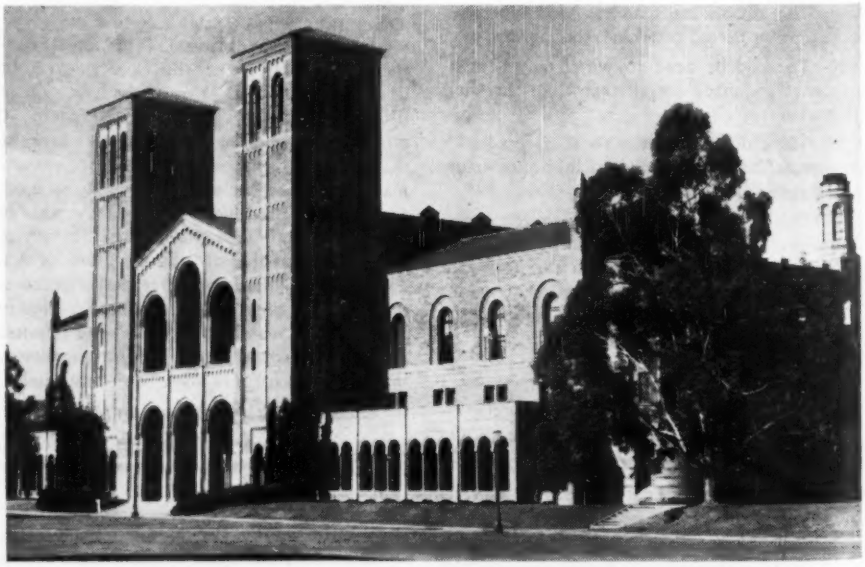
Assistant Chairmen: Wesley L. Orr, E.S.M.W.T., University of California, Los Angeles, and John C. Dillon, E.S.M.W.T., University of Calif., Los Angeles, Calif.

Address, by Dr. Clarence A. Dykstra, provost, University of California at Los Angeles.

Jet-Propulsion Principles and Rockets for Assisted Take-Off, by M. J. Zucrow, executive engineer, Aerojet Engineering Corporation, Azusa, Calif. (illustrated by films).

Jet-Propelled Airplanes, by Col. Homer Boushey, Commanding Officer of 412th Fighter Group, Bakersfield Army Air Field, Bakersfield, Calif. (illustrated by films).

(*Program continued on following page*)



ROYCE HALL, UNIVERSITY OF CALIFORNIA AT LOS ANGELES, CALIF.

TUESDAY, JUNE 12

7:00 p.m.

Aviation—Heat Transfer I

Chemistry Building, Room 134

Chairman: Haydon S. Gordon, Ryan Aircraft Company, San Diego, Calif.

Assistant Chairman: G. T. Rowe, Douglas Aircraft Company, Santa Monica, Calif.

Electrical Ignition for Aircraft Internal-Combustion Heaters, by E. H. Plesset, supervisor, M. S. Plesset, analytical group engineer, and J. D. McCrumm, all of the electrical research laboratory, and T. N. Floyd, supervisor, mechanical research laboratory, Douglas Aircraft Company, Santa Monica, Calif.

The Influence of Tube Shape on Heat Transfer Coefficients in Air to Air Heat Exchangers, by Frederick H. Green and Leighton S. King, heat-transfer engineers, AiResearch Manufacturing Co., Los Angeles, Calif.

7:00 p.m.

Aviation—Production I

Chemistry Building, Room 19

Standard and Quality Control

Chairman: Clifford Bell, E.S.M.W.T., University of California at Los Angeles, Calif.

Assistant Chairman: Preston Hammer, quality-control division, Lockheed Aircraft Corporation, Burbank, Calif.

Fundamentals of Statistical Quality Control, by John Howell, standards analyst, Northrop Aircraft, Inc., Hawthorne, Calif.

Gaging Standards With Statistical Quality Control, by Wallace Johnson, chief of gaging laboratory, Douglas Aircraft Company, El Segunda, Calif.

Telescopic Application to Airframe and Tool Inspection, by Milton Gray, president, Erb and Gray Scientific Instrument Company, Los Angeles, Calif.

7:00 p.m.

Aviation—Rubber and Plastics

Chemistry Building, Room 234

Chairman: John Delmonte, technical director, Plastics Industries Technical Institute, Los Angeles, Calif.

Assistant Chairman: (*To be announced*)

Design Consideration of High Strength Reinforced Plastics in Relation to Future Aircraft, by W. I. Beach, North American Aviation, Inc., Inglewood, Calif.

Design Considerations for Aircraft Molded Parts, by Eric Marx, Plastics Consultant, Los Angeles, Calif.

Structural Laminates for Aircraft, by Carrol Sachs, plastics consultant, Los Angeles, Calif.

7:00 p.m.

Aviation—Instruments and Regulators

Chemistry Building, Room 45

Chairman: Ray Ellinwood, president, Adel Precision Products Corporation, Burbank, Calif.

Assistant Chairman: Walter C. Trautman, Pacific Division, Bendix Aviation Corporation, North Hollywood, Calif.

New Developments in Combination Controls, by John W. Kelly, chief engineer, Adel Precision Products Corporation, Burbank, Calif.

Electronic Recording of High-Speed Pressure Transients in Fluid Systems, by Sydney Westman and Edward Partington, development engineers, Pacific Division, Bendix Aviation Corporation, Los Angeles, Calif.

Latest Development in Aircraft Controls, by A. L. Baak, regional director, western division, and W. K. Ergen, project physicist, Minneapolis-Honeywell Regulator Company, Los Angeles, Calif.

7:00 p.m.

Aviation—Applied Mechanics

Chemistry Building, Room 56

Chairman: C. H. Heilbron, senior research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Assistant Chairman: J. L. Brewster, Alhambra, Calif.

Cumulative Damage in Fatigue, by Milton A. Miner, strength test engineer, Douglas Aircraft Company, Santa Monica, Calif.

An Empirical Approach to Fatigue Strength Analysis of Structures, by H. W. Foster and Victor Seliger, research engineers, Lockheed Aircraft Corporation, Burbank, Calif.

A Device for Indicating Sequence of Regional Failure of Static Test Specimens, by Richard W. Powell, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

WEDNESDAY, JUNE 13

7:00 p.m.

Aviation—Heat Transfer II

Chemistry Building, Room 134

Chairman: W. W. Reaser, Douglas Aircraft Co., Santa Monica, Calif.

Assistant Chairman: Wilson Tripp, Ryan Aircraft Co., San Diego, Calif.

The Behavior of the Hot-Wire Anemometer Under Fluctuating Flow, by R. C. Martinelli and Ross Randall, University of California, Berkeley, Calif.

Design of a Low Temperature Altitude Chamber, by C. J. Lyall, North American Aviation, Inc., Inglewood, Calif.

7:00 p.m.

Aviation—Management

Chemistry Building, Room 45

Chairman: V. L. Pieckii, manager of tool engineering, Lockheed Aircraft Corporation, Burbank, Calif.

Assistant Chairman: Richard Omara, Western Precipitation Corp., Los Angeles, Calif.

Aircraft Organization, by John W. McFarland, Organization and Control, Lockheed Aircraft Corporation, Burbank, Calif.

What the American Society of Civil Engineers Has Done on Unionization, by A. M. Rawn, chief engineer and general manager, Los Angeles County Sanitary District, Los Angeles, Calif.

Work Simplification in Low-Quantity Manufacturing, by E. C. Osborn, assistant manager, Tool Engineering Division, Lockheed Aircraft Corporation, Burbank, Calif.

7:00 p.m.

Aviation—Production II

Chemistry Building, Room 19

Chairman: John C. Dillon, E.S.M.W.T., University of California, Los Angeles, Calif.

Assistant Chairman: F. R. Adler, Los Angeles, Calif.

Philosophy of Standardization, by G. M. Aron, standards engineer, Northrop Aircraft, Inc., Hawthorne, Calif.

Standardization and Interchangeability, by B. C. Boulton, Douglas Aircraft Company, Santa Monica, Calif.

7:00 p.m.

Aviation—Metals Engineering

Chemistry Building, Room 340

Chairman: Bruce E. DelMar, engineer, Douglas Aircraft Company, Santa Monica, Calif.

Assistant Chairman: (*To be announced*)

Distortion Due to Contour Forming of Extrusions and Sheet-Metal Sections, by William Schroeder, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Strength of Heat-Treated Steel Parts, by E. R. Metz, research engineer, Lockheed Aircraft Corp., Burbank, Calif.

7:00 p.m.

Aviation—Power Plants

Chemistry Building, Room 234

Chairman: Cliff Collins, assistant chief engineer, Kinner Motors, Inc., Glendale, Calif.

Assistant Chairman: Prof. S. F. Duncan, University of Southern California, Los Angeles, Calif.

Carburetor Air Filters, by Richard S. Farr, Farr Corporation, Los Angeles, Calif.

Engine Testing, by Jack Intlekofer, Pico, Calif.

7:00 p.m.

Gas Turbines and Jet Propulsion, II

Room to be announced

Chairman: M. J. Zucrow, executive engineer, Aerojet Engineering Corporation, Azusa, Calif.

Assistant Chairman: T. A. Watson, educational supervisor, E.S.M.W.T., University of California.

The Place of the Gas Turbine in Aviation, by Charles D. Flagle, design engineer, aviation gas-turbine division, Westinghouse Electric and Manufacturing Company, Essington, Pa.

Gas-Turbine Fundamentals, by D. D. Streid, project engineer, supercharger engineering division, General Electric Co., Lynn, Mass

THURSDAY, JUNE 14

7:00 p.m.

Aviation—Heat Transfer III

Chemistry Building, Room 134

Chairman: W. E. Mason, University of California at Los Angeles, Los Angeles, Calif.

Assistant Chairman: E. H. Morrin, department of engineering, University of California at Los Angeles, Calif.

Heat Anti-Icing Design Experiences, by Howard Schmidt, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.

Anti-Icing of Aircraft Windshields, by Albert A. Arnhym, consulting engineer, Solar Aircraft Comany, San Diego, Calif.

7:00 p.m.

Aviation—Production III

Chemistry Building, Room 19

Chairman: Thomas A. Watson, educational supervisor, E.S.M.W.T., University of California.

(*Program continued on following page*)

Assistant Chairman: John C. Dillon.

Production Control, by F. R. Adler, Industrial Engineering Service Company, Los Angeles, Calif.

Design Studies for Cost Reduction, by Paul Tietsche, special project engineer, Development Engineering Group, Consolidated-Vultee Aircraft Corporation, Vultee Field, Calif.

7:00 p.m.

Aviation—Hydraulics

Chemistry Building, Room 45

Chairman: Ralph E. Middleton, chief engineer, Aireon Manufacturing Corporation, Burbank, Calif.

Assistant Chairman: A. Hollander, consulting engineer, Byron-Jackson Co., Los Angeles, Calif.

High Pressure Hydraulic Systems, by Richard L. Hayman, Lockheed Aircraft Corporation, Burbank, Calif.

High-Speed Centrifugal Pumps, by W. N. Curtis, Thompson Products, Inc., Inglewood, Calif.

7:00 p.m.

Aviation—Applied Mechanics Instruments and Regulators

Chemistry Building, Room 340

Chairman: William Schroeder, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Assistant Chairman:

Mechanical Oscillators and Their Electrical Synchronization, by B. J. Lazan, Sontag Scientific Corporation, Greenwich, Conn.; S. W. Herwald, miscellaneous engineering department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.; and R. W. Gemmell, manager, aviation engineering section, Westinghouse Electric & Manufacturing Company.

An Acceleration Damper: Development, Design, and Some Applications, by Paul Lieber and D. P. Jensen, Douglas Aircraft Company, Inc., Santa Monica, Calif.

Charts for Fuselage Torsion Vs. Control Surface Flutter, by William T. Thomson, engineering design research, Ryan Aeronautical Company, San Diego, Calif.

Actions of A.S.M.E. Executive Committee

At Meeting Held at Headquarters, March 23, 1945

A MEETING of the Executive Committee of The American Society of Mechanical Engineers was held in the rooms of the Society on March 23, 1945. There were present Alex D. Bailey, chairman; R. F. Gagg, vice-chairman; A. C. Chick, D. W. R. Morgan, and A. R. Stevenson, Jr., of the Committee; J. J. Swan (Finance), A. R. Mumford (Local Sections), K. W. Jappe, treasurer, R. M. Gates, junior past-president; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

The following actions were of interest.

Life Memberships

The staff was authorized to make available to members information on life membership in the Society. (A statement regarding life membership will be found on page 362 of this section.)

Group Delegates Conference

Authorization was voted of the holding of the Group Delegates Conference at Chicago in June instead of New York in November.

Specification for Shackles

Organization of an A.S.M.E. special standards committee to prepare standard specifications for fastening devices such as shackles was authorized.

Pension Plan

The report of the tellers on the Pension Plan was received. (See page 362 of this section.) A Pension Committee to prepare the necessary procedures and policies in accord with the basic outline of the plans approved by the members of the Society by letter ballot, for submission to the Executive Committee, was appointed as follows: Member at large, to serve three years, George L. Knight; the chairman of the Finance Committee in office, to serve one year; and J. L. Kopf, to serve one year.

Joint Conference Committee

Various matters discussed by the Joint Conference of Past-Presidents and Secretaries were reported and the following actions were taken:

(1) The President was authorized to appoint a committee of three, with R. M. Gates as chairman, to serve until the 1945 Annual meeting to carry on the activities of the Society in international relations. The Committee on Organization was asked to give early attention to the establishment of the necessary permanent organization to deal with international relations pertaining to engineering.

(2) Approval was voted of a Joint Committee on Status of the Engineer to report to the Joint Conference Committee and each society to co-ordinate its activities on economic status. A.S.M.E. representatives on the Joint Committee on Status of the Engineer are E. G. Bailey, L. A. Appley, and P. T. Onderdonk; advisory members, Elliott Dunlap Smith and R. E. Doherty.

(3) Approval was voted of the establishment of the Joint Committee on Organization as an agency of the Joint Conference Committee.

(4) Approval was voted of the setting up of the Committee on Industrial Disarmament of Aggressor States and the National Engineers Committee to deal with the same problem as agencies of the Joint Conference Committee.

(5) Approval was voted of the change of name from Joint Conference Committee to the Engineers' Joint Council.

Appointments

The following appointments were approved:

Standardization Sectional Committee on Rotating Electrical Machinery, Charles D. Wilson; Minimum Requirements for Plumbing and Standardization of Plumbing Equipment, A. H. Morgan; Graphical Symbols and Abbreviations for Use on Drawings, W. J. Kunz.

Special Research Committee on Furnace Performance Factors, G. R. Milne, L. B. Schneler.

Boiler Code Subcommittee on Ferrous Materials, M. S. Northrup and W. C. Stewart.

National Honors Committee, Comfort A. Adams, William L. Batt, Ralph Budd, Vannevar Bush, Harvey N. Davis, Robert E. Doherty, Gano Dunn, W. F. Durand, E. E. Elliott, Charles Edison, R. E. Flanders, Lieut. Gen. W. H. Harrison, Hon. Herbert Hoover, C. F. Kettering, W. W. Nichols, J. C. Parker, W. E. Wickenden, Orville Wright.

American Academy of Political and Social Science, Annual Meeting, Philadelphia, April 13–14, 1945, H. S. Harris, F. W. Miller, Walter Samans.

Regional Conferences

A.S.M.E. Council representatives at Regional Conferences of Local Sections: Group I, Waterbury, Conn., May 10–11, A. R. Stevenson, Jr.; Group II, New York, N. Y., May 17–18, D. W. R. Morgan; Group III, Schenectady, N. Y., May 14–15, A. C. Chick; Group IV, Atlanta, Ga., May 21–22, F. L. Wilkinson, Jr.; Group V, Detroit, Mich., May 24–25, Roscoe W. Morton; Group VI, Lafayette, Ind. (Purdue) June 1–2, A. E. White; Group VII, Salt Lake City, Utah, June 8–9, R. F. Gagg; Group VIII, Tulsa, Okla., June 4–5, T. S. McEwan.

Advisors of A.S.M.E. Manufacturing Committee Meet at Ann Arbor, March 8 and 9

THE Manufacturing Engineering Committee of The American Society of Mechanical Engineers has been assisted in its work on milling research by an advisory committee composed of engineers from prominent machine-tool companies.

One of the research projects of the Committee has been established at the California Institute of Technology (Caltech), Pasadena, Calif., and another at the University of Michigan, Ann Arbor, Mich. Both of these projects are sponsored by the Office of Production Research and Development of the W.P.B.

The work done at Caltech covers the milling of steel, both normalized and heat-treated, using cutters of various designs tipped with a variety of carbides. The carbide cutters are set for both negative axial and negative radial rake angles.

Carbide tipped cutters are also being tested at the University of Michigan but here the tests are being run on cast metals using cutters having positive rake angles.

The investigations carried on at both projects cover the length of tool life and factors that contribute to the breakdown and dulling of the tools. A number of reports have been made of each project and have been printed in a series of data sheets published by the Manufacturing Engineering Committee.

A meeting of the Advisory Committee was held at the University of Michigan, March 8 and 9, 1945, for the purpose of discussing the work done at the two projects during the last six months and the proposed schedule for the coming period. Both Prof. O. W. Boston, who is in charge of the research at the University of Michigan, and R. O. Catland, supervisor of the Caltech project, expressed the opinion that their findings up to this point,

ADVISORY COMMITTEE TO THE MANUFACTURING ENGINEERING COMMITTEE (A.S.M.E.) FOR O.P.R.D. RESEARCH PROJECTS ON MILLING

(*Seated, left to right:* Prof. A. E. White, director of department of engineering research, University of Michigan, visitor; J. B. Armitage, Kearney & Trecker Corporation; Richard A. Wolff, chief of industrial processes branch, Office of Production Research and Development, War Production Board, Washington; R. O. Catland, supervisor of project at C.I.T.; P. F. Popp, International Harvester Company, Chicago; R. F. Onsrud, Onsrud Machine Works, Inc.; N. A. Lombard, Douglas Aircraft Co.; F. M. Gibian, Northrop Aircraft, Inc.; Herbert B. Lewis, chairman of Manufacturing Engineering Committee. *Standing, left to right:* Fred Colvin, A.S.M.E.; Prof. O. W. Boston, supervisor of project at University of Michigan; P. Dubosclard, Paragon Research, Inc.; Hans Ernst, Cincinnati Milling Machine Co.; A. William Meyer, Brown & Sharpe Manufacturing Co. (substituting for Ben Graves); A. A. Schwartz, Bell Aircraft Corporation; Prof. W. W. Gilbert, University of Michigan, visitor; Prof. L. V. Colwell, University of Michigan, visitor; Richard B. Smith, executive secretary, Manufacturing Engineering Committee. *Attended meeting, but missing from photograph:* Charles S. Hill, Jr., deputy chief, Industrial Processes Branch, O.P.R.D.; R. W. Dayton, Battelle Memorial Institute; H. K. Work, Jones & Laughlin Steel Corporation. Other members of the committee not shown are: J. S. Chaffee, director, tool division, W.P.B. Washington, D. C.; B. P. Graves, director of design, Brown & Sharpe Manufacturing Co.; J. S. Halderman, division manager, Tool Engineering, Lockheed Aircraft Corporation.)

while not final, show definite trends in the use of carbide-tipped cutters. These trends are shown by charts developed at the projects and shown in the data sheets.

The interest in these reports shown by the Advisory Committee and the readers of the data sheets is indicative of the benefit derived by industry at large from the milling projects.

L. K. Sillcox Honored

THE Council of the Institution of Locomotive Engineers (England) has awarded the Gold Medal of the Institution to L. K. Sillcox, fellow A.S.M.E. and 1943 A.S.M.E. Medalist, for his paper, "Power to Pull: A Comparison of the Operating Characteristics Exhibited by Steam and Diesel-Electric Locomotives," presented to the Institution on July 29, 1942.

C. R. Soderberg and R. B. Smith Honored

TWO A.S.M.E. members were honored when the Society of Naval Architects and Marine Engineers awarded the Joseph H. Linnard Prize jointly to Prof. C. Richard Soderberg, professor of mechanical engineering, Massachusetts Institute of Technology, and Ronald B. Smith, director of research and development, Elliott Co., Jeanette, Pa., for their paper, "The Gas Turbine as a Possible Marine Prime Mover," which was presented at the annual meeting of the S.N.A.&M.E., held in New York, N. Y., Nov. 11 and 12, 1943.

S. L. Cluett Wins Longstreth Medal

THE 1945 award of the Longstreth Medal of The Franklin Institute will be made to Sanford Lockwood Cluett, member A.S.M.E., vice-president, Cluett Peabody and Company "in view of the fundamental nature and mechanical ingenuity displayed in the development of the process for the preshrinking of woven fabrics, known as Sanforizing."

Ericsson Drawings Given to Stevens

HARVEY N. DAVIS, president, Stevens Institute of Technology, has announced a bequest to the College from its late dean, Franklin De Ronde Furman, a set of about 70 drawings from which Capt. John Ericsson's *Monitor* was built. The *Monitor*, 83 years ago March 21, defeated the Confederate frigate *Merrimac* and brought to an end the era of wooden warships. In New York State the day was observed as John Ericsson Day by proclamation of the Governor. Thirty-four of the working drawings, hitherto unpublished and little known, are attributed directly to Captain Ericsson whose iron-clad war vessel with revolving turret turned the tide of naval warfare in favor of the United States at Hampton Roads, Va., on March 9, 1862, and revolutionized naval warfare.

P.F.M.A. Elects Officers

THE Propeller Fan Manufacturers Association, at its Annual Meeting, Feb. 21, 1945, elected the following officers: H. M. Guilbert, B. F. Sturtevant Company, president; E. C. Englert, Hartzell Propeller Fan Company, vice-president; and V. C. Shetler, 2-255 General Motors Building, Detroit 2, Mich., secretary-treasurer.

Oil and Gas Power Meeting Postponed

IN view of the government restrictions at present applying to the holding of meetings and conventions, the Executive Committee of the Oil and Gas Power Division of the A.S.M.E. announces regretfully that the 1945 meeting will not be held as scheduled.

Milwaukee, Wisconsin, selected during last year to be the site of the 1945 meeting, is to be retained as the scene of the meeting for 1946 and as many as practicable of the plans for the now-deferred event will be carried through to next year.

President's Page

Engineers in Management

OVER a period of years there have been two developments or trends in business and industry which are of major importance to engineers: the first is the increasing number of engineers taking important managerial and executive positions; and the second, the increasing importance of sound management principles and practices in our industrial and economic development. The war has accentuated these trends, and its demands upon American business and industry have required all the skill that management could muster. Under such pressure, and faced with such a challenge, men in positions of management have sought every possible assistance in finding better ways and means to deal with men and materials. Government agencies and the Armed Forces have devoted much time to the development of better methods of management, all of which have made a substantial contribution to our success in the present emergency. Management as an art, as a science, and as a profession is rapidly coming into its own.

Too frequently engineers become so involved in the technical aspects of their work that they overlook the importance of techniques and skills involved in management and human affairs. They find themselves in positions of managerial responsibility with only technical preparation. It is important that we as a society give some thought to this important phase of an engineer's activity. When a good engineer becomes a poor manager it is a tragedy; when a good engineer becomes an able executive, no better combination can be found in the field of management.

Recognizing the responsibility of our Society in this field, the Management Division is doing a good job in stressing the importance of managerial ability and in keeping this important subject of engineers in management before the membership. Its objective is, and always has been, "to develop a sound philosophy of management and techniques for applying the engineering approach in behalf of more effective and efficient organization and operation; this to be done through the preparation and discussion of papers and reports, the processes of research, education, and other appropriate means." The management activities should be ranked on the highest level with the many other activities of the Society which demand our attention. Our engineering skill can be most fully utilized only in proportion to our managerial or executive capacities.

(*Signed*) ALEX D. BAILEY, *President*, A.S.M.E.

Local Sections

E. F. Riesing Talks to Metropolitan Section on Synthetic Rubber

ELLWOOD F. RIESING, member A.S.M.E., chief automotive engineer, Firestone Industrial Products Company, Detroit, Mich., was the speaker at a meeting held on Feb. 19, 1945, in the Engineering Societies' Building, New York, N. Y. His subject, "Synthetic Rubber in Automotive Chassis—Status and Future Possibilities," was illustrated with an extensive array of dynamic tests and models, operated on the platform, and prepared especially for the presentation. Mr. Riesing, who has spent many years in the solution of problems involving the use of rubber in the automotive and aviation fields, spoke with authority from a rich background of experience. He is at present chairman of the Rubber and Plastics Division of the A.S.M.E.

In his talk, which was taken from a paper written by him and published by his company, he said in part:

"I am endeavoring to familiarize you with the properties of various synthetic elastomers on the market today, that is, their static and dynamic properties and their resistance to various conditions. I am also predicting what may be made available in the postwar years in the way of physical properties in special-purpose synthetic elastomers.

"With full realization of the fact that highly functional synthetic-rubber mechanical-goods parts demand that designing engineers have full knowledge of the synthetic elastomer compounds they plan to use, various engineers in the industries have requested data at operating temperatures and not at room temperature on such properties as: Resilience, dynamic modulus, both in shear and compression, static modulus, both in shear and compression, tension modulus at specified elongations, creep, hardening, and also data on low-temperature stiffening and brittleness.

"We have endeavored to meet this request, not only by the presentation of synthetic-rubber data in this talk, but also by demonstrating some of their physical properties with specially built equipment, so as to give you visual proof of the superiority of some of the synthetic rubber compounds over natural rubber compounds for mechanical rubber-goods parts."

To simplify his talk, Mr. Riesing limited his data for the most part to the properties of five general-utility mechanical-goods stocks, compounded from the indicated basic synthetic elastomers available commercially on the market today.

Copies of Mr. Riesing's address are available and may be obtained by writing to him at Firestone Industrial Products Company, 1405 Henry St., Detroit, Mich.

H. L. Whittemore Reviews 25 Years of Washington, D. C., Section

"Looking Backward"

AT the 25th anniversary of the Washington, D. C., Section, held at the Roger Smith Hotel in Washington, D. C., H. L. Whittemore gave a talk on the history of the Section, entitled "Looking Backward." From his paper we give a brief summary.

The war brought many engineers to Washington in 1917 and they brought their ideas. They did new and interesting war work and were anxious to discuss it and tell others about it. After the members of the A.S.M.E. returned from the Annual Meeting in New York they resolved to have a section in Washington and called a preliminary meeting December 9, 1918. Sixty engineers attended. A.S.M.E. Council was petitioned to authorize a section in Washington, and the section was formed early in 1919 with Dr. Samuel Wesley Stratton, chairman; Prof. Geo. A. Weschler, secretary; Maj. J. Henry Klink, Arthur E. Johnson, and H. L. Whittemore.

First Met at Cosmos Club

For the first few years the section was permitted to meet in the elite Cosmos Club. When the Potomac Electric Power Building was constructed in 1930 the section met in the auditorium.

Although Washington has few engineering industries, it is filled to the brim with government. More and more prominent men, especially those exploiting new and unusual ideas, find it necessary to come to Washington "on business." Our section easily persuades them to occupy our platform in the hope of winning converts or, at least, having their proposals better understood. About half the subjects have been military, ranging from materials to submarines, from ships, tanks, big guns, and aircraft onward and upward to Preparedness and National Defense. The nonmilitary subjects covered materials (wood, steel, coal, and gas), processes (welding), structures from screw-threads to locomotives, houses, and streetcars to aircraft, and boilers and gas turbines to Hudson River bridges. The high point in programs was reached when Dr. Lyman J. Briggs took us up 60,000 ft above sea level in the beautifully illustrated lecture on the Stratosphere Flight, 1937. General subjects ranged from sewage disposal and smoke abatement in the District of Columbia to Muscle Shoals and Giant Power; from inventions, patents, research, and standardization to management and waste in industry.

Engineering students are a major concern of our society. They are the blood donations of the country to engineering societies. Prizes have been awarded regularly for the best paper by a student; sometimes the prizes were trips to annual meetings in New York, expenses paid. In 1942 there was a course of lectures by experts on Applied Mechanics. Two hundred were interested.

A Liberty Ship was launched in 1944 by the Bethlehem Shipbuilding Corporation, with our enthusiastic approval and applause.

Patents

In 1930 I. H. Fullmer, chairman, Washington Section, formed a committee to investigate the relation between employer and employed patentee. He asked for a recommendation similar to a code of ethics. Lieut. Col. Chas. G. Mettler, Ordnance Department, U. S. Army, was chairman. Two years later the commitee reported to Harvey Boltwood, then chairman of the Section, that because the subject was so complex and difficult it was recommended that the committee be disbanded and the problem turned over to American Engineering Council. Later, the Council reported, giving a summary of patent policy in many different fields.

The American Engineering Council was formed in 1917. One of our members, L. W. Wallace, was executive secretary after 1921. In April, 1919, Council formed a committee on Classification and Compensation of Engineers with Arthur S. Tuttle, chairman. One objective was to increase the pay of government engineers. This was in no sense a trade-union movement to boost pay but a serious effort to see that the taxpayer got his money's worth. The Classification Act was passed in 1923 and still is in effect. American Engineering Council labored mightily on this worthy project. Perhaps this success in getting engineers to push all together turned our heads because the very next year, 1924, a report of our Committee on Engineer and the Federal Service got nowhere.

Salaries of Government Engineers

In 1928 the A.S.M.E. formed a committee on Economic Status of the Engineer. The engineering schools in this country had compiled data on the salaries of graduates and plotted

A.S.M.E. National Nominations

THE 1945 Nominating Committee invites Members to appear at its open meeting June 18, 1945, at the Hotel Stevens, Chicago. Members may present their views concerning candidates for the offices of President, Regional Vice-President, or Delegate at Large, any time between the hours 10 a.m. to 12 noon, or 2 p.m. to 4 p.m.

This year the Committee is proceeding on the assumption that the proposed reorganization of Council will be approved. Specific instructions have been sent to all Local Section Executive Committee chairmen and secretaries.

graphs, showing the relation of years after graduation to salary. This work gave basic data with which the salaries of groups such as mechanicals could be compared. Chairman A. E. Hanson of the Washington Section appointed a committee to obtain similar information on salaries of government engineers. The conclusions reached were: (1) The average salary is but little above the upper boundary of the minimum 25 per cent for all engineering graduates. (2) For the first few years the average salary is appreciably higher than the average for all engineers. (3) Twenty years after graduation the average salary is appreciably less than the average for all engineers. It was pointed out that government service was particularly suited to some engineers, and also a young engineer was wise if he got experience in the government, often on new and unusual work, made wide acquaintance outside, then "cashed in" elsewhere.

A.S.M.E. Fiftieth Anniversary

At the Fiftieth Anniversary of the A.S.M.E. the Washington Section really came into its own. It undoubtedly was the most stupendous event in the life of the section. I need not remind you that The American Society of Mechanical Engineers was founded in New York in 1880. To commemorate fittingly the tremendous achievements of mechanical engineers, our Society held elaborate exercises in New York, N. Y., at Stevens Institute, Hoboken, N. J., and in Washington, D. C. Engrossed greetings and congratulations were formally presented here in Washington by 450 delegates from scientific, technical, military, and governmental organizations all over the world. Outstanding engineers of international renown to the number of 16 were honored and presented with medals before a distinguished audience. Our own Herbert Hoover received the first Hoover Medal endowed in perpetuity by Past-President Conrad Lauer.

Anthracite-Lehigh Valley Section

At the March 23 meeting, held at the Hotel Washington, Hamburg, Pa., a paper entitled "Hydraulic Handling of Materials," by F. B. Allen of Allen-Sherman-Hoff Co., Philadelphia, Pa., was presented by William B. Stephenson, junior member A.S.M.E., mechanical engineer, Allen-Sherman-Hoff Co., as Mr. Allen was not able to attend because of ill health. The paper described the use of hydraulic material-handling equipment for removing overburden in open-pit mining. Mr. Hare then described the use of such equipment in Florida phosphate mines, and L. E. Mylting, member A.S.M.E., shop superintendent, Allen-Sherman-Hoff Co., gave a brief description of the equipment itself. At the close of the meeting the entire audience visited the shop of Allen-Sherman-Hoff Company

Baltimore Section Hears Discussion on Ground Water

Robert R. Bennett, speaking at the March 26 meeting at the Engineer's Club, Baltimore, Md., discussed the occurrence of ground water in the Baltimore area, covering the history of ground-water development; the relation of geology to the occurrence of ground water; hydrology; quality of the water; and the economic importance of ground water in Baltimore.

Boston Section Hears Nathan Janco

"Centrifugal Casting" was the subject at the March 15 meeting at Northeastern University, Boston, Mass., when Nathan Janco, junior member A.S.M.E., and chief engineer, Centrifugal Casting Machine Co., Tulsa, Okla., summarized the methods of manufacturing centrifugal, semicentrifugal, and centrifuged castings of ferrous and nonferrous metals in both horizontal and vertical molds. Numerous slides showed the procedure and results obtained for a variety of castings. A very interesting discussion developed relating to quality of product, gating and speeds of operation.

The Helicopter Discussed at Central Illinois Section

A joint meeting was held on March 19 with the Peoria section of S.A.E., at the Jefferson Hotel, Peoria, Ill., when Bartram Kelly, assistant director, Helicopter Division, Bell Aircraft Corporation, Buffalo, N. Y., discussed "The Postwar Family Airplane—the Helicopter." Mr. Kelly gave details on Young's rotor, the mathematical problems as well as the mechanical problems. He said that two full-scale units have been built and flown successfully, and although considerable success has been achieved up to the present time, a great deal remains to be done. Colored movies illustrated the lecture which was attended by 200.

Chicago Section Features Powdered Metals

A symposium on powdered metals was featured at the Feb. 26 meeting held at the Hamilton Hotel, Chicago, Ill. The speakers were Dr. J. E. Drapeau, Jr., technical director, Metals Refining Company; James J. Kux, vice-president, Kux Machine Company, and Nordberg Koebel, director of research, Lindberg Engineering Company. Dr. Drapeau described the methods of preparing powdered metals, their characteristics and variations. Mr. Kux described the presses used for forming the powders, and illustrated with slides a number of the machines. He also exhibited several finished parts made on the machines.

"Postwar Wage Structures" was the subject at the Mar. 12 meeting held at the Hamilton Hotel, Chicago, Ill., when Thomas S. McEwan, vice-president, A.S.M.E., discussed labor's position in our postwar industrial economy. He analyzed various wage-payment plans and emphasized the great need for cooperation between management and labor in order to achieve our national goal of full employment. He pointed out that labor's share of our national income must be commensurate with its contribution to our national production. Sixty members and guests attended.

Study of Stoker Fuel Beds Featured at Cleveland Section

One-hundred and fifty members and visitors attended the March 8 meeting at the Cleveland Engineering Society, Cleveland, Ohio, when Otto de Lorenzi, member A.S.M.E., Director of Education, Combustion Engineering Company, New York, N. Y., spoke on "Study of Stoker Fuel Beds." Mr. deLorenzi, who is an authority on combustion, explained furnace operation with different types of coal and different draft conditions Colored motion pictures of fuel beds were used to illustrate his talk. Mr. de Lorenzi, who has always been an enthusiast with the camera, conceived the idea of taking motion pictures of the interior of furnaces in actual operation and making use of these films to improve stoker and burner designs.

Dr. Ernest Abbott Speaks to Colorado Section

At the March 7 meeting in Salt Lake City, Utah, Dr. Ernest Abbott, member A.S.M.E., spoke on "The Profilometer Goes to War." His subject, a timely one, was of great interest to the audience, as was evidenced by the many questions asked Dr. Abbott during the question period.

Discuss G. I. Bill of Rights at Dayton Section

"The G.I. Bill of Rights" was discussed by G. W. Nagel and R. C. Matthies at the March 20 meeting held at the Engineers' Club, Dayton, Ohio. High-school students were invited to attend this meeting.

Panel Discussion on Power-Plant Design at Detroit Section

At a dinner meeting on March 6 at the E.S.D. Auditorium, Detroit, Mich., a panel discussion was held on "The Elements of Simplicity in the Design of Power Plants. The speakers were George C. Daniels, member A.S.M.E., Max W. Benjamin, member A.S.M.E., and Prof. Hugh E. Keeler, Fellow A.S.M.E. A method was outlined whereby all phases of design in power plants can be reduced to the utmost simplicity, so that cost and efficiency will become balanced without sacrifice of one over the other. Members and visitors totaled 200.

A panel discussion on "Modern Power Plant Design and Operation" was the feature of the Mar. 20 Junior Section meeting at the Engineering Society, Detroit, Mich. Messrs. Geisinger, Green, and Griffiin, engineers with The Detroit Edison Company, explained reasons behind design and how operating methods are changed because design has not worked out as expected.

An inspection was made of the Ford Motor Co.'s Rouge plant (aircraft engine) at Detroit, Mich., on April 3, when the construction, assembly, and test of the eighteen Pratt and Whitney design aircraft-engine cylinder was observed.

East Tennessee Section Meets With A.I.E.E.

At a joint meeting with the A.I.E.E., on March 22 at the S&W Cafeteria, Knoxville, Tenn., Merrill Demerit spoke on "Intercon-

nected Transmission Operation." Fifty-three members and guests heard this interesting talk.

Greenville Section Elects New Officers

New officers were elected on March 29 by the Section as follows: A. Keith Pooser, chairman; E. M. Williams, vice-chairman; J. W. Vaughan, Jr., secretary-treasurer. New executive committee members are: Sam B. Earle, Peter P. Kriek, Robt. H. Chapman, Ralph S. Pruitt, and George R. Morgan. The nominating committee consists of Robt. B. Fuller, chairman, with John O. Lindsay and Charles E. Waddell.

Hartford Section Hears Talk on Electronics

A. H. Moore, electronic-control specialist of the New York District of the General Electric Company, was the featured speaker at the March 20 meeting at Trinity College chemistry auditorium. His subject "Application of Electronics in Industry," covered welding controls, including precision timers and recent developments in control for "difficult-to-weld" metals; photoelectric controls; process timers; electronic exciters and electronic rectifiers; Thyratron reactor controls for lighting; electronic-heating and electronic measurement devices. The lecture was illustrated with slides.

Talk on the Profilometer at Inland Empire Section

"The Profilometer Goes to War" was the subject presented by Frank W. Kavat, Physicists Research Co., Ann Arbor, Mich., at the meeting on March 23 at the Spokane Hotel, Spokane, Wash. In his talk Mr. Kavat said that mass production of machine parts requires accurate means of gaging the roughness of finished surfaces. The profilometer, employing a diamond tracer point whose movements are amplified on an electric-meter dial, has provided the means.

"Reverse Cycle Heating" Talk at Ithaca Section

The March 9 meeting was held jointly with the A.I.E.E. Ithaca Section and Steuben Chapter of P.E., at the Mark Twain Hotel, Elmira, N. Y. G. K. Marshall of the General Electric Company spoke on "Reverse Cycle Heating." One hundred and six members and guests attended.

C. D. Dosker, Speaker at Louisville Section

At the Feb. 15 meeting at the Speed Auditorium, Louisville, Ky., the paper published in MECHANICAL ENGINEERING, December, 1944, by C. D. Dosker and A. C. Knauss, entitled "Laminating Lumber for Extreme Service Conditions," was discussed by C. D. Dosker, vice-president, Gamble Brothers, in great detail, with emphasis on prospective applications. Slides of the construction of landing boats using laminated timbers were shown. These boats were also shown in action to illustrate the severity of the service under which they must perform.

"Industrial Economy in the South" Subject at Memphis Section

Eugene O'Brien, past vice-president, A.S.M.E., managing editor of Southern Power and Industries, Atlanta, Ga., vice-president of W. R. C. Smith Publishing Company, engineer and consultant for the War Manpower Commission, and chairman of the American Society of Military Institutes, was the speaker at the March 9 meeting, held at the Hotel Peabody, Memphis, Tenn. Mr. O'Brien discussed the problem of developing a stable industrial economy in the South, and his excellent analysis was of great interest to his audience.

Metropolitan Section Holds Inter-American Night

The Metropolitan Section held its first Inter-American Night at the Engineering Societies Building, New York, N. Y., on April 20, in the interest of improving export relations with South American countries.

The speakers were Anibal Santos, engineer of the export division, Combustion Engineering Company, New York, N. Y., who spoke on conditions in Ecuador in regard to foreign trade with the U. S., and Chandra R. Saksena, export representative in Brazil and head of the Rio de Janeiro Business Training School. Mr. Saksena gave a very accurate account of the opportunities in Brazil and stressed the need for a closer understanding of the attitude and customs of the Brazilian people as an aid to strengthening our foreign commerce relations.

A panel of experts in Latin American affairs from Business Publishers International, New York, N. Y., gave highly valuable information on the foreign-trade situation in respect to engineering products and machinery in Latin America. The panel consisted of Loran Emery, Lloyd J. Hughlett, J. Seward McCain, and F. Joseph Muller all connected with the magazines *Ingenieria Internacional Industria Construcion* and *Ingenieria Internacional Construcion*.

"Practical Machine Design" Talk at Mid-Continent Section

On March 6 the Section met at Stillwater, Okla., to hear D. O. Barrett, chief mechanical engineer, Gulf Oil Company, discuss "Practical Machine Design." Mr. Barrett illustrated his talk with a number of machine parts which showed the important features that must be considered in order to obtain workable and practical machinery which is adapted for service in the field. Many examples were presented from the speaker's wide experience here and abroad to illustrate his points.

Prof. E. C. Baker, head of the mechanical-engineering department, Oklahoma A&M, presided as chairman of the program. Members and guests attended a buffet dinner prior to the evening's program.

John M. Knight Speaks at New Haven Section

John M. Knight of the American Car & Foundry Company spoke on "Modern Railway Equipment" at the March 14 meeting held in Mason laboratory. The speaker briefly reviewed the development of the railroads, and then presented some of the problems confronting car designers, with special emphasis on the innumerable regulations. The present and postwar choice of construction materials was outlined, implying no radical changes from the past.

Oregon Section Hears Louis C. Fogg

"Trial Testing of Motor Ships" was the subject at the meeting on Feb. 16 when Louis C. Fogg, chief trial engineer, Commerical Iron Works, Portland, Ore., was the speaker. Mr. Fogg outlined the many tests required of the propulsion, deck, service, and steering equipment for both dock trials and trial runs, as used aboard the various types of craft which are built by his company. Such tests and the methods of conducting them, he said, are prescribed by various rules of the U. S. Navy and Maritime Commission and must be recorded before acceptance and commissioning by any purchaser.

Prof. Paul B. Eaton Speaks at Philadelphia Section

At the Engineers Club, Philadelphia, Pa., on Feb. 27, the Section heard Prof. Paul B. Eaton, member A.S.M.E., speak on "Engineering Opportunities in China." Professor Eaton discussed the subject from firsthand observation and made the meeting a most interesting one. A total of 170 members and guests attended.

On March 27 Col. J. Carroll Cone, assistant vice-president, Pan-American Air Lines, spoke at the Engineers Club, on "Postwar International Air Transportation." He discussed at length the coming international agreements for air transportation and advocated a single American transocean international air company owned by all air and shipping lines, but under strict government control. One hundred and sixty-two members and guests attended the meeting.

"Gas-Turbine Application" Talk at Plainfield Section

Stanley A. Tucker, junior member A.S.M.E., associate editor of *Power*, was the guest speaker at the March 21 meeting held in the Elks' Club, Elizabeth, N. J. His lecture entitled "Next Steps in Gas Turbine Application" outlined what can be expected in the way of new developments within the next several years on gas-turbine applications. With his talk, a sound film was shown, the product of Allis-Chalmers Company, which explained what a gas turbine is in layman language. One hundred attended this interesting meeting

Prof. C. Richard Soderberg Speaker at Providence Section

At the March 6 meeting held in the Engineering Society building, Providence, R. I., Prof. C. Richard Soderberg, member A.S.M.E., of Massachusetts Institute of Technology, Cambridge, Mass., discussed gas turbines and

jet propulsion. An audience of 125 agreed that the evening was far too short, so greatly interested had they been in Professor Soderberg's talk.

Chicago "Daily News" War Correspondent Heard at Rock River Section

At a joint meeting of the Section with the Rock River Engineering Council on Feb. 26, at Beloit, Wis., David Nichol, war correspondent for the *Chicago Daily News* spoke on "Russia as I See It." Mr. Nichol described his recent experiences in Russia, and emphasized particularly the Russian war effort in the field and in the factories. He explained the attitude and point of view of the Russian people on the war and on postwar arrangements. A question period followed his talk. Over 300 members and guests of the various societies attended, among them T. S. McEwan, vice-president, A.S.M.E., who came from Chicago for the meeting.

A joint meeting was held on March 15 with the University of Wisconsin Branch, when Paul R. Sidler, resident engineer, Brown, Boveri & Co., Ltd., Baden, Switzerland, presented his paper on "The Velox Boiler and Gas Turbines." There was a long and lively question period after the lecture. Firsthand information on Velox boilers is somewhat scarce, so those present made good use of the opportunity to learn about them. The audience numbered about 70. The Section feels that Mr. Sidler should be especially recommended to other sections for similar lectures.

Railroad Developments Discussed at St. Louis Section

W. H. Hobbs, director of research, Missouri Pacific Lines, was the speaker at the Feb. 23 meeting. In his talk on railroad developments, Mr. Hobbs pointed out some present-day accomplishments, such as freight trains of 12,000 and even 14,000 tons gross weight which are successfully handled; the carrying capacity of cars as much as three times their own weight; and locomotives in service today which produce 1250 hp for each driving axle. The modern engine, he said, burns only about half as much coal to make a pound of steam as did the locomotive of 40 years ago and gets nearly twice as much work out of each pound of steam after it is made. Mr. Hobbs said that present-day research is largely directed toward passenger and shipper consideration, i.e., greater speed and more comfort. The prime objective of the train communication systems which are now being developed is improved operation, although safety, too, will be improved. Diesels, Mr. Hobbs said, have been used by the Missouri Pacific for a number of years on switch engines and have justified the economics of this type of power, while Diesel passenger power has certain advantages which make it desirable for important fast trains.

San Francisco Section Hears Talk on Welded Structures by Harry E. Kennedy

A dinner meeting was held at the Engineers' Club, San Francisco, Calif., on March 1, when Harry E. Kennedy spoke on "Welded Structures and Some Causes of Their Failure." Mr. Kennedy is co-inventor of the "Unionmelt" process and is well known to many of the Section members. His talk was based upon experimental welds that he had tested, with an interpretation of the results of these tests as related to full-size structures and failures which have occurred.

National Supply Company Hosts to Southern California Section

On Feb. 28 the Section was guest of The National Supply Company, Torrance, Calif. The hosts first served dinner, then gave a short talk on the company's local and national facilities by D. S. Faulkner, member A.S.M.E., and vice-president of the Company, and Jack Morgan, works manager of the Torrance plant. The members were then guided in groups of ten on an inspection tour of the plant facilities, climaxed by the observation of the pouring of a 25-ton steel heat which was specially scheduled to be run at the time of this inspection tour. The tour was enjoyed by 80 members of the Section which is deeply indebted to the management and personnel of The National Supply Company for their courtesies.

On Mar. 13 the Section held its regular monthly dinner meeting at the Clark Hotel, Los Angeles, Calif., when the speaker was Dr. Ernest Abbott, member A.S.M.E., and president of Physicists Research Company, Ann Arbor, Mich. Dr. Abbott's paper "Profilometer Goes to War," proved extremely interesting. He gave a short history of the development of his company over the last six years, and its progress correlated with some of the principal world events. Stereoptican slides illustrated the description of the profilometer. A number of these instruments are in use in the Southern California area, in the aircraft industry. Eighty members and guests were present.

Dr. Ernest Abbott Speaks at Utah Section

Dr. Ernest Abbott, member A.S.M.E., president of the Physicists Research Company, Ann Arbor, Mich., presented his paper "The Profilometer Goes to War" at the luncheon meeting on March 9. Members and guests were interested in Dr. Abbott's masterly presentation of the subject and all joined in an informal talk with him after the meeting.

Washington, D. C., Section Hears Dr. J. E. Younger

"The Development of Modern Aircraft Structures" was the subject of a talk by Dr. John E. Younger, member A.S.M.E., at the March 8 meeting in the Potomac Electric Power Co. auditorium, Washington, D. C. Dr. Younger, who is professor and chairman of mechanical engineering, University of Maryland, College Park, Md., is one of the pioneer aircraft engineers of the United States. His talk was illustrated with 40 slides which traced the development of the airplane structures from the time of the Wright Brothers up to the present time. Dr. Younger emphasized the tremendous advances that have been made, not only structurally, but aerodynamically, and called attention to future possibilities.

Western Washington Section Meets With Other Founder Society Sections

"Wings of War and Peace" was the subject at the March 20 meeting held in the Chamber of Commerce, Seattle, Wash. This was the annual joint meeting of the four Founder Societies. The speaker, Fred P. Laudan, vice-president, Boeing Aircraft Co., told of the development of Boeing ships and pointed out how the same wing structures were used on the B-15 bomber and the famous clippers; on the B-17 fortresses and on the stratoliners; on the B-29 super-fortress and the new stratocruiser that recently broke the transcontinental speed record.

At the meeting on March 26 at Chamber of Commerce, Seattle, Wash., Frank Kavat, of the Physicists Research Co., Ann Arbor, Mich., spoke on the development of the profilometer and the growth of his company. To illustrate his talk he showed slides of many industrial applications of the instrument.

Fuels and Lubricants in Wartime Feature at West Virginia Section

Dr. C. W. Butler of the Gulf Research & Development Company, substituted at the Feb. 27 meeting at the Daniel Boone Hotel, Charleston, W. Va., for R. J. S. Pigott who was unable to attend. Dr. Butler, in presenting the subject "Wartime Considerations Regarding Fuels and Lubricants," used Mr. Pigott's notes. Some popular conceptions of high-octane fuel and its use in the average car were corrected. A short description of the postwar engine was given, in which the chief feature will be low fuel consumption and improved efficiency of operation. The postwar car, Dr. Butler explained, will be very much like the 1942 model. He also described the need and effects of standardizing military fuels and lubricants. A lively discussion followed.

Joint Meeting of Western Mass. Section and Engineering Society

A joint dinner meeting of the Western Massachusetts Section and the Engineering Society of Western Massachusetts was held at the Hotel Sheraton, Springfield, Mass., on March 20, with 65 members and guests present. The guest speaker was Prof. Paul B. Eaton, member A.S.M.E., department of mechanical engineering, Lafayette College, Easton, Pa., whose subject was "The Engineers of China—Their Hopes, Ambitions, and Fears." Professor Eaton compared the China of 25 years ago with that of today, and told of the emphasis which is being placed on education, particularly upon the applied sciences and engineering. He said that social strides are being made and explained the effect these would have on the future. He envisaged a great future for China. Lantern slides illustrated the talk, and a discussion period followed at the close of the lecture.

Student Branches

University of British Columbia

The Branch held three meetings in January and four in February when the students presented papers and engineering films were shown. At the Feb. 26 meeting a film tracing the development of aircraft from the Wright Brothers down to the fighters and bombers of today was the feature.

On March 2 a field trip was made to the Neon Company's engineering division. This plant is manufacturing precision electrical equipment and meters for the Canadian Government.

Two student papers were presented at the March 4 meeting. Len Taylor read a paper on "Maintenance of Electric Motors," and Dave Taylor one on "Lubrication of Bearings."

On March 12 two films were shown; the first, entitled "The River," traced the history of the Mississippi River with special emphasis on the T.V.A. The second showed the refining of gold in the Royal Mint.

At the March 19 meeting a library committee was appointed to purchase books for the A.S.M.E. library.

Ross Hattee was selected as the winner of the best paper of the year, at the meeting on March 26. The prize was $15 worth of books, the winner to make his own selection. Len Wannop was elected to receive the Certificate of Award.

University of Cincinnati Branch

A meeting of the Branch was held on Feb. 28 at the Student Union Building. Fred R. Armstrong was appointed temporary treasurer to take care of the Branch's financial affairs during Mr. Shaeffer's illness. It was decided to enter the intramural athletic program events.

The Branch held a meeting on March 14 at the Student Union Building. The co-op day committee reported that there would be no co-op day because of lack of students but that the A.S.M.E. had been asked to co-operate with pre-freshman day. A short discussion of intramurals followed. A picnic was planned for March 24 to initiate the new athletic equipment purchased by the Branch.

University of Colorado Branch

The February meeting was held jointly with the Denver sections of the A.S.M.E. and S.A.E., at Denver, Colo. K. D. Wood, member A.S.M.E., of the University of Colorado, gave a discussion on the preliminary design of helicopters. The outstanding student meeting discussion was given by George D. Doty on the principles, maintenance, and repair of small home and commercial refrigeration units.

Cooper Union Branch

An organization meeting of The Cooper Union Branch was held on Jan. 19 at the Hewitt Building, when officers for the current quarter were elected as follows: Arthur Zahradnick, chairman; Evelyn Kern, vice-chairman and secretary; Elliot Kohn, treasurer. It was decided that all members act on all committees, and that some of the future meetings be held jointly with other engineering societies. The members were also urged to prepare papers for presentation later in the quarter.

Two films were shown at the meeting on Feb. 20 at the Hewitt Building. One, a G. E. picture entitled "The World's Largest Electrical Workshop," showed the assembly of the huge motors and generators and the production of new postwar articles. The other picture, "Railroadin'," showed in technicolor the great advances railroads have made in the past 75 years. Several students were asked to present short papers on different features of gas turbines at the next meeting. A film will be shown on the same topic.

Cornell University Branch

On Feb. 14 the final gathering of the Branch for the fall-winter term was held in the Olin Hall recreation room. It was announced that John Kreuter and Richard C. McCarthy had won first and second prizes in the A.S.M.E. speech contest. The winners were presented with engraved keys bearing the University seal and John Kreuter also received a copy of Marks' "Mechanical Engineers' Handbook."

A.S.M.E. STUDENT BRANCH AT UNIVERSITY OF COLORADO

University of Idaho Branch

On Feb. 28 the Branch traveled to Pullman, Wash., where a representative of Allis-Chalmers gave an interesting talk and showed a film on the development of gas turbines. The meeting was held at Washington State College engineering building.

University of Kansas Branch

John Martin was the speaker at the Feb. 9 meeting held in the Union Building. Mr. Martin, who is a mechanical-engineering graduate of Georgia Tech., and at present production manager at Sunflower Ordnance Plant, gave an interesting talk on the production of rocket powder at the Sunflower Ordnance Plant. Following his talk, Mr. Martin showed samples of various kinds of rocket and gun powder.

Lehigh University Branch

H. E. Linsley, public-relations department, Curtiss Wright Corporation, was the featured speaker at the March meeting held at Packard Laboratory. His talk on "Aviation Today and Tomorrow," was most interesting. He discussed the development of the Wright Cyclone engines and concluded with observations about postwar aviation. He stressed the development of postwar commercial aviation and pointed out that civilian aviation is not nearly as promising as has been advertised by current literature. Following his talk, a film on the Wright Cyclone engine was shown.

University of Louisville Branch

On Feb. 9 at the Speed Scientific School the following officers were elected for the present term: R. S. Johnson, chairman; J. Bennett, vice-chairman; G. Weber, corresponding secretary; D. McDaniels, student council representative; E. Dotson, sergeant at arms; W. W. Heimerdinger, librarian. The social program consisted of a film entitled "Wheels Across India."

Marquette University Branch

An interesting program was presented as the first meeting of the new year on Jan. 29 in the student room, when Mr. Cameron of Froemming Shipyards, Milwaukee, Wis., told of his past experiences as an engineering officer in the U. S. Navy, and of his present work as chief engineer in charge of construction of 4000-ton-capacity cargo vessels. He invited the Branch to attend an inspection trip of the ships.

On March 19 the first meeting of the current semester was held, when Harry Jessell, a graduate of Marquette Engineering School, and at present an engineer for the Vilter Manufacturing Company, told of his company's contribution to the war effort and illustrated his talk with slides. His discussion of the work on refrigeration and air conditioning was helpful and interesting.

University of Maryland Branch

The second meeting of the winter quarter was held on March 14, at the University, when the Branch met with members of the A.S.C.E., A.I.E.E., and A.I.Ch.E. for a joint engineering session. Bureau of Mines motion pictures were shown featuring the Diesel engine and stainless steel.

University of Michigan Branch

C. E. Chayne, chief engineer in charge of engineering at the Buick Motor Division plants

A.S.M.E. STUDENT BRANCH AT UNIVERSITY OF MICHIGAN

at Flint, Mich., and Melrose Park, Ill., was the speaker at the Feb. 7 meeting at Rackham Amphitheater. He showed a motion picture which followed the work on radial aircraft engines from the first operations through the final testing. The picture also showed the latest innovations in foundry, machining, assembly, and testing practice; as well as showing operations on 20 millimeter and 75 millimeter shells, gears, and the M-18 tank destroyer, with views of the tank destroyer in action. After Mr. Chayne's interesting talk a discussion period followed, when he answered questions on manufacturing problems, engine performance, and postwar automobile design trends.

University of Minnesota Branch

At the March 23 meeting in Coffman Memorial Union, Lt. (j.g.) Tresille of the Navy V-12 Unit gave a lecture on the various countries and ports he had visited on his tour of sea duty. The talk was illustrated with colored movies, and the audience found the pictures of Italy after conquest particularly interesting. So vividly did Lt. Tresille describe his sea trip that the audience found itself on a vicarious voyage of the Atlantic.

New Mexico State College Branch

On Feb. 20 the meeting was devoted to a very interesting report on fibreglass, the high lights of its history, use, manufacture, and future possibilities, by C. A. Rowland, Jr., president of the Branch. A film entitled "Three to Be Served," was then shown. This film, made available by the Castle Film Corporation, portrayed how good management satisfied the investor, the laborer, and the consumer.

New York University Branch

At the Feb. 23 meeting several films were shown dealing with the production of aluminum. These were "Mine to Metal," "Fabrication Processes," and "Unfinished Rainbows."

A joint meeting was held with the N.Y.C. Student Chapter of the I.A.S. on March 2 at New York University, when the guest speaker was Prof. F. K. Teichmann, member A.S.M.E., head of the aeronautical-engineering department at N.Y.U. Professor Teichmann discussed the various unsolved aeronautical problems which are being encountered in practice. A discussion period followed.

Northeastern University Branch

At a noon meeting on March 15, at the University, the Branch drew up a program of activities for the spring season. Included in the plans were student speakers and visits to several local power plants.

On March 20 the Branch was conducted on a tour of the Ward Street sewage-pumping station in Boston, Mass. Piston-type pumps were actuated by two 75-ft-high marine-type Corliss engines; steam was supplied at 150 psi to the 5-ft-stroke behemoths. The resident engineer said that Monday is the busiest day of the week, while thaws accounted for the largest monthly flow during March.

On March 27 the Branch attended the E.C.P.D. sponsored meeting for junior engineers held at the University. Dean William C. White of the college of engineering opened the meeting and introduced the speakers. Harold B. Richmond, chairman of the board, General Radio Corporation, and a member of the E.C.P.D., spoke on the subject of "Plan Your Work, Then Work Your Plan." He stressed the need of continuing one's engineering education after graduation, and of entering social and forward-looking movements. He concluded his talk with a short history of the E.C.P.D. Dr. Albert Haertlein of the Harvard graduate school of engineering, and present chairman of the Massachusetts registration board for engineers, sketched the history of the engineering licensing board in the Commonwealth, and gave the requirements needed for registration. He said that the real purpose of registration is to bring about solidarity in the engineering profession. Dr. Haertlein remarked that there are 1100 registered engineers in Massachusetts, 29 per cent of whom are mechanical engineers. A brief discussion period followed.

Ohio State University Branch

A meeting was held Feb. 16 at Robinson Laboratory, following which members of the Branch visited the clinic of veterinary medicine.

On Feb. 23 the Branch met at Robinson Laboratory. It was decided to keep the same secretary and treasurer for the rest of the year, but pass the chairmanship around. John McClelland was elected chairman and John Babbitt vice-chairman. A discussion period followed at which the subject "Should There Be Conscription During Peacetime?" was chosen.

At the March 2 meeting a discussion was conducted by E. J. Lindahl on the new 5-year engineering course.

A short meeting was held on March 9, part of which the members spent in the photography department on the campus.

Polytechnic Institute of Brooklyn Branch

A joint meeting was held on Feb. 20 with the Aeronautical Society, in the Assembly room. An address was made by Mr. Linsley of the Wright Aeronautical Corporation. The major part of the talk consisted of a discussion of postwar probabilities in flying, and the adaptation of gas turbines in large planes. Motion pictures on the construction of Wright Cyclone engines were shown. After the meeting the students were shown through the Ruppert plant, where Mr. Morrow, a plant engineer, explained the processes necessary in brewing beer.

The final meeting of the winter term was held on March 13. Professor Ming of the Institute introduced the speaker, Walter R. Place, a native of New England, who is now with the American Can Co. Mr. Place gave a talk on modern production methods and tool and die design, and told of Navy orders filled by a subsidiary of the American Can Co. in the production of torpedoes. After the program Harry Rich, president of the Branch, thanked all committeemen and officers for their good work and praised the untiring work and guidance received from Prof. E. F. Church, honorary chairman. An election was held and Professor Church and Harry Rich were unanimously re-elected honorary chairman and president, respectively. Milton Meyer was elected vice-president, Salvatore Coppola, treasurer, and Dominick Casale, secretary.

At an executive meeting held March 16, the following members were elected for committee work: Roy Olsen and Michael Grosso, refreshment committee; Frank Le For, and Frank Raffa, tour committee; Allan Zang and

Harold Levine, publicity; William Germer, photographer; Harold Hillowitz, Reinhold Kissner, and Frank Marcsiseck ,program committee; and Ronald Kriegel, magazine committee.

Purdue University Branch

At the March 27 meeting held in the mechanical-engineering building, the annual speech contest was conducted for the purpose of selecting an A.S.M.E. member to represent Purdue at the regional convention at Northwestern University in May. The first prize of $10 was won by John Colby who discussed "Aircraft Vibrations." Second prize winner was Crews Perkey whose topic was "Design and Production of the Weasel." Larry Nielsen won third prize, speaking on the "Development of Postwar Radio." The fourth winner, Leonard Sax, spoke on "Modern Methods of Weather Forecasting," basing his talk on his past experiences in the meteorology department of the U. S. Marine Corps.

University of Southern California Branch

A short meeting was held on March 12 in the engineering building when President Pfirrman introduced the newly appointed honorary chairman, Vincent C. George, member A.S.M.E. Mr. George, who is lecturer in mechanical engineering at the University, gave a short talk on the A.S.M.E. Copies of MECHANICAL ENGINEERING were distributed.

Southern Methodist Branch

At the Feb. 21 meeting held in the engineering building of the University, the following officers were elected: W. W. Griffith, president; Ed. Rollor, vice-president; G. L. Buttler, secretary, and J. W. Harrison, treasurer.

Moving pictures were the feature of the meeting on March 17. The first film illustrated the fundamentals of metal filing, and three reels illustrated oil-well drilling.

Swarthmore College Branch

At the March 14 meeting held in Hicks Hall, the following officers were elected to serve for the coming semester: John Kelly, chairman; Don Skelley, vice-chairman, and Neil Gilmour, secretary-treasurer. Ray Winch was elected chairman of the program committee, and Robert Gage was chosen to assist him. A short discussion was held on the type of program desirable and suggestions were made that speakers include faculty members, outside engineers, industrialists, and students who would give research talks.

Tufts College Branch

The first meeting of the spring term was held on March 12 at Robinson Hall, when new officers were elected: R. S. Smith, chairman; W. S. Young, vice-chairman; and R. D. Bunker, secretary-treasurer. Future plans and activities were discussed informally.

A delegation of Branch members and faculty attended the A.S.M.E. Local Section meeting held at Northeastern University on March 15. The subject of centrifugal casting was discussed and illustrated by Nathan Janco, junior member A.S.M.E.

On March 19 a U. S. Training film on mechanical refrigeration was shown. Fundamental principles of refrigeration and its naval application in regard to cooling systems aboard ship were covered. Prof. R. U. Fittz attended the meeting and made pertinent comments on the subject matter.

A group of members from the Branch attended the E.S.N.E. meeting at Northeastern University on March 27. The topics of particular interest to the Branch members were "Building an Engineering Career" by Harold B. Richmond, and "Registration of Engineers" by Prof. Albert Haertlein of Harvard.

Worcester Polytechnic Institute Branch

Oscar Payne, inventor of the Thompson submachine gun, was the guest speaker at the March 30 meeting at Higgins Laboratories. Mr. Payne traced the development of firearms from their early history to the present day. He explained the principles involved in all types of firing mechanisms from flintlocks through percussion caps to fixed ammunition. He told of reloading systems, including the recoil and exhaust-gas types, and touched on variations of these principles. In conclusion, he demonstrated a Thompson submachine gun—the light-weight, 0.45-caliber gun which he invented and developed for the Army at the outbreak of the first world war. The gun is named in honor of General Thompson who gave Mr. Payne the contract for the weapon.

Yale University Branch

On March 6 an organization meeting was held in Mason laboratory when S. R. Sulis was elected chairman; E. R. McNutt, secretary; and C. H. Christiansen, treasurer.

At the meeting on March 13 several interesting talks were given, including one on "Model Truck Building," by E. J. Pommer. On March 20 J. Hassell spoke on "Jobs for G. I. Joe;" and I. Ross entitled his talk "The Mosquito." Another meeting on March 27 featured "Uses for High Vacuum," by H. Shober; and "Cryptanalysis" was the talk given by J. Gloss on April 3.

A.S.M.E. STUDENT BRANCH AT NEW MEXICO STATE COLLEGE

(*Front row, left to right:* Joseph H. Gold, John M. Hursh, Eva C. Blanchard, Chester A. Rowland, Claudio F. Oliver, and Prof. A. M. Lukens. *Back row, left to right:* Pete F. Triviz, John R. Sellars, Robt. E. Reding, Joe T. Budenholzer, Kenneth A. Powell, and Joe R. Romero.)

Engineers Requested to Submit Problems for Students

THE A.S.M.E. Committee on Relations With Colleges, Dean G. L. Sullivan, chairman, has undertaken a project in cooperation with the Mechanical Engineering Division of the Society for the Promotion of Engineering Education to obtain problems encountered by practicing engineers for the use of teachers in engineering colleges. Many engineers have expressed the opinion that too often problems are assigned to students which do not encourage students to think, analyze, or develop an answer which requires the student to begin with simple fundamentals. It is the hope of the joint committees that engineers will submit problems from time to time which they encounter in practice. Problems of an elementary nature as well as more involved problems are desired.

Problems in any of the following groups will be acceptable: Air conditioning, fluid mechanics, fuels, heat transfer, heating and ventilating, internal-combustion engines, lubrication, machine design, mechanism, pumps, refrigeration, steam power (turbines, steam generators, auxiliaries, etc.), stress analysis, thermodynamics, and vibration. Economic considerations in the problems for any of the group are highly desirable.

The problems will be made available to engineering teachers through the pages of "Heat Power News and Views" and the "Machine Design Clearinghouse Bulletin" of the Society for the Promotion of Engineering Education. Eventually, a pamphlet of problems may be published by the Committee on Relations With Colleges.

Problems should be sent to:
Problem Project,
The American Society of Mechanical Engineers,
29 West 39th Street,
New York, N. Y.

A few minutes spent in rewriting problems which you have had occasion to solve will be time devoted to a noble cause. If you do not care to have your name published with the problems, mark them anonymous, or request deletion of your name.

A.S.M.E.-A.I.E.E. Preferred Standards for Condensing Steam Turbine Generators Available

COPIES are now available of a pamphlet, "Preferred Standards for Large, 3600-Rpm, 3-Phase, 60-Cycle Condensing Steam Turbine Generators (larger than 10,000-kw rated capacity)," prepared by the Joint Committee on Steam Turbine Generators of the American Institute of Electrical Engineers and The American Society of Mechanical Engineers. The standards have been approved by the A.I.E.E. Board of Directors and the A.S.M.E. Council for one-year trial use.

The Joint Committee was established by the A.I.E.E. Board of Directors and the A.S.M.E. Council to prepare preferred standard ratings and characteristics that would closely fit the requirements of purchasers, the selection of operating pressures and temperatures, and the fixing of standard extraction temperatures for the various units.

These standards do not prevent the purchase of any size of steam turbine generator desired for any set of operating conditions different from those indicated in the standards. They are progressive standards which permit technical and economic development and should be reviewed at least annually to determine whether advances in the art call for specific modification.

Significant Features

The significant features of the standards shown in the attached tabulation of ratings and characteristics are:

(1) Six standard unit ratings from 11,500 kw to 60,000 kw, inclusive.

(2) One or two standard values of throttle pressure and temperature for each rating.

(3) Definite number of extraction openings for each machine, with specified values of saturation temperature at each opening when operating at turbine-generator rating with full extraction from all openings.

(4) Specification that the guaranteed turbine capability, in kilowatt output at the generator terminals, shall be 10 per cent above the turbine-generator rating of each unit, instead of the 25 per cent margin usually provided in the past.

(5) Specification that the power-factor rating of the generators shall be 85 per cent at the generator rating, yet provide greater kva capacity in proportion to the capability of the turbine than in present designs; also that the short-circuit ratio of the generators shall be 0.8 at generator rating.

(6) The two smaller units will have air-cooled generators, while the four larger sizes will have hydrogen-cooled generators, the latter rated for normal operation with 0.5 psig hydrogen pressure and with 15 per cent additional kva capability above generator rating provided by increasing the hydrogen pressure to 15 psig.

It is recommended that purchasers consider use of these preferred standards in procuring new steam-turbine generator capacity.

Standard Specification Data for Generators

In addition to the Standards for Turbine Generators, which were prepared by the Joint Committee, "Standard Specification Data for Generators" has been prepared by the A.I.E.E. Group of the Joint Committee. The data cover detail information that will assist in the standardization of the generators.

Personnel of Joint Committee

Representing the A.I.E.E. on the Joint Committee were 10 members with M. S. Oldacre, equipment and research engineer, Commonwealth Edison Company, Chicago, as chairman. The A.S.M.E. was represented by 9 members with K. M. Irwin, assistant to vice-president, charge of engineering, Philadelphia Electric Company, Philadelphia, Pa., as chairman, and A. L. Penniman, Jr., general superintendent, electric operations, Consolidated Gas Electric Light and Power Company, Baltimore, Md., as acting chairman.

PROPOSED PREFERRED STANDARDS FOR LARGE 3600-RPM 3-PHASE 60-CYCLE CONDENSING STEAM TURBINE GENERATORS

	Air-cooled generator		Hydrogen-cooled generator —rated for 0.5 psig hydrogen pressure—			
Turbine rating, kw	11,500	15,000	20,000	30,000	40,000	60,000
Turbine capability, kw	12,650	16,500	22,000	33,000	44,000	66,000
Generator rating, kva	13,529	17,647	23,529	35,294	47,058	70,588
power factor	0.85	0.85	0.85	0.85	0.85	0.85
short-circuit ratio	0.8	0.8	0.8	0.8	0.8	0.8
Throttle pressure, psig	600	600	850	850	850 or 1250	850 or 1250
Throttle temperature, F	825	825	900	900	900 or 950	900 or 950
Number of extraction openings	4	4	4	5	5	5
Saturation temperatures 1st	175	175	175	175	175	175
at openings at "tur- 2d	235	235	235	235	235	235
bine-generator rating" 3d	285	285	285	285	285	285
with all extraction 4th	350	350	350	350	350	350
openings in service, F 5th	...	...	...	410	410	410
Exhaust pressure, inches Hg abs	1.5	1.5	1.5	1.5	1.5	1.5
	Hydrogen-cooled generator operated at 15 psig hydrogen pressure					
Generator capability at 0.85 power factor, kva			27,058	40,588	54,117	81,176

A tolerance of plus or minus 10 F shall apply to above saturation temperatures. (Tolerances shall be unilateral so as not to reduce the spread in temperature between adjacent extraction openings.)

The turbine capability is guaranteed continuous output at generator terminals when the turbine is clean and operating under specified throttle steam pressure and temperature and exhaust pressure, with full extraction from all extraction openings.

A.I.C.E. Proposes Plan to Promote Postwar Employment

The following statement of a plan for the promotion of postwar employment has been adopted by the American Institute of Consulting Engineers.

The close of the World War will make it necessary, in order to win the peace, to find employment for upward of at least 7,000,000 members of the present armed services and for a change in the employment of from 8,000,000 to 10,000,000 civilians who have been engaged in the production of war materials. Upon the surrender of Germany this problem will have to be faced in part.

Programs have been and are being developed for the construction of public works designed to absorb a portion of the masses requiring employment, but such a program on a large scale must, of necessity, be short-lived and dependence should ultimately be placed upon private enterprise for the absorption of the vast majority of those who otherwise would be jobless.

It is the opinion of the American Institute of Consulting Engineers that the following procedure should be observed in order to encourage our industries and attract investment capital to the extent required for providing full employment in all fields:

1 Legislation should be enacted which would clearly place under one control the functions, now independently exercised by separate agencies, with respect to price fixing, production of goods, and wages so that all of them may be co-ordinated while such controls are needed, and in this way provide assurance that private enterprise may have a fair measure of security against loss.

2 The Attorney General should be requested to co-operate with the Director of War Mobilization and Reconversion in laying down clear-cut policies for the guidance of private enterprise in the observance of anti-trust laws.

3 Free enterprise should be relieved of the present necessity of furnishing a multiplicity of federal agencies with information as to business operations, much of which is of little value, but compiled at great expense.

4 The tax structure should be adjusted in such a way as to provide for meeting current needs as far as practicable, and at the same time to encourage investment of capital. It should also be simplified so as to relieve the taxpayer of a multiplicity of taxes with incidental details. Among the changes there should be included a discontinuance of double taxation on distributed corporation profits, and a repeal of the tax on undistributed and excess profits.

Opportunity for industrial activity was never more promising, provided that essen-

tial capital is made available, and such activity will be reflected in and stimulate every field of endeavor with the result of providing full-time employment for all. On the other hand, in the absence of measures for the protection of capital there would be lacking an incentive to put it to the active use essential for the promotion of private enterprise. More particularly, active capital is faced with taxes which might readily prove an incentive to hoarding; it is burdened with a requirement to make frequent reports concerning details of its business to many agencies at great cost and inconvenience; it is faced with price controls which might mean doing business at a loss; and it is threatened with prosecution in case of an attempt to set up standards for volume of production and reasonable profits.

In the belief that the adoption of the plan herein proposed would accomplish its purpose, it is urged that all agencies give it careful and serious consideration.

Management Course at University of Iowa

THE University of Iowa, College of Engineering, Iowa City, Iowa, has announced a management course devoted to production planning, plant layout, motion and time study, wage incentives, and related subjects. The course is for three weeks—June 11 to June 29, 1945, and is intended for plant managers, foremen, industrial engineers, methods and time-study analysts, cost accountants, and office executives. It will be held in Iowa City, Iowa.

War Production Conference Chicago Technical Societies

SPONSORED by members of the Chicago Technical Societies Council, Chicago War Production Conference was held at the Stevens Hotel, Chicago, Ill., on March 29, in co-operation with the U. S. Army, U. S. Navy, and War Production Board.. This conference included 36 panel sessions sponsored by the various institutes and societies of the Council. At a luncheon in the grand ballroom the address "Building Firepower Through Technology" was delivered by Major General Levin H. Campbell, Jr., Chief of Ordnance, U. S. Army. At the dinner Clarence G. Stoll, president, Western Electric Co., New York, N. Y., made an address on "Battle Front Report." Educational exhibits of war-production equipment and practice were tied in with the panel subjects. Panel No. 25 "Management" was sponsored by the Society for Advancement of Management and The American Society of Mechanical Engineers and included talks on "Trends in Collective Bargaining," "Employment of Women," "Utilization of Returning Veterans," and kindred subjects.

American War Standards for Drawing and Drafting-Room Practice

AT the request of the War Production Board the American Standards Association is starting to develop a series of American War Standards for drawing and drafting-room practice that will correlate the practices of the Army and Navy with those of industry.

The American Standards Association has long had a regular committee on Drawing and Drafting-Room Practice working under the joint technical leadership of The American Society of Mechanical Engineers and the Society for the Promotion of Engineering Education. Standards developed by this Committee have laid down the simple basic elements of the subject. This new work requested by the Military proposes to carry the subject further into the complicated realm of modern industrial production.

Work on these new War Standards has already started. It is being financed by the War Production Board through an already existing Government contract under which the A.S.A. has since July, 1942, completed 88 standards of direct concern to the war effort and has under development some 68 more.

The Military have outlined the scope of the work to include civil, mechanical, electrical, aeronautical, and marine engineering.

The following subjects will be covered:

1 Abbreviations.
2 Methods of indicating and specifying threads.
3 Methods of lettering.
4 Drawing forms and sizes.
5 Graphical, diagrammatic, and schematic symbols.
6 Methods of indicating and specifying materials.
7 Methods of indicating and specifying finishes.
8 Methods of dimensioning and indicating tolerances.
9 Methods of numbering drawings.

Special emphasis is laid upon completing work on the first five subjects at an early date.

Other items, such as a system of numbering parts, type designations, fastening devices, allowances and tolerance, can be taken up as time permits.

American Foundrymen's Association Awards

FOR distinctive contributions in the field of cast metals, the Board of Awards of the American Foundrymen's Association recently awarded gold medals and honorary life memberships in the Association to five outstanding leaders of the foundry field. Those honored are:

Robert E. Kennedy, member A.S.M.E., secretary, American Foundrymen's Association, the Joseph S. Seaman Gold Medal of A.F.A. "for outstanding meritorious service to all branches of the Foundry Industry through his work in organizing and guiding the development of technical and operating papers and discussions, and his untiring encouragement to all A.F.A. chapters, committees, and members."

C. E. Sims, supervising metallurgist, Battelle Memorial Institute, Columbus, Ohio, the John A. Penton Gold Medal of A.F.A. "because of his outstanding contribution to the Steel Casting Industry."

M. J. Gregory, retired, Honorary Life Membership in A.F.A. "for his contribution to the Association and the Foundry Industry."

Rear Admiral A. H. Van Keuren, U.S.N., director, Naval Research Laboratory, Anacostia, D. C., Honorary Life Membership in A.F.A. "in recognition of his efforts in behalf of the Foundry Industry."

Honorary Life Memberships in A.F.A. were also awarded to Ralph J. Teetor, president, Cadillac Malleable Iron Co., Cadillac, Mich., president of the American Foundrymen's Association, 1944–1945, and to R. E. Kennedy and C. E. Sims, the 1945 medalists.

Prizes Offered for Resistance-Welding Papers

THE Resistance Welder Manufacturers Association, Philadelphia, Pa., is conducting a prize contest for outstanding papers dealing with resistance-welding subjects. A prize of $500 is offered for the best paper emanating from an industrial source, consulting engineer, government laboratory, or the like, in which the major portion of the subject matter is concerned with design for resistance welding. Two prizes of $200 each are offered to the authors of two papers, not primarily concerned with design, which, in the judgment of the Board of Awards, are the greatest original contributions to the advancement and use of resistance welding. One of these prizes is to go to the best paper emanating from a university source, and the other for the best paper emanating from an industrial source. A fourth prize of $100 will be awarded to the author of the best remaining paper, which may fall in any of the three groups mentioned. The contest is considered as having opened Sept. 1, 1944, and will close at midnight, July 31, 1945.

L. F. Moody Awarded Cresson Gold Medal

THE Franklin Institute, Philadelphia, Pa., has announced that Stanford Caldwell Hooper, Real Admiral, U.S.N. (retired) and Prof. Lewis F. Moody, member A.S.M.E., of Princeton University, are winners of the Elliott Cresson Gold Medals for 1945. Since the founding of the Cresson Medal in 1848, it has been awarded by the Institute "for discovery or original research, adding to the sum of human knowledge, irrespective of commercial value" to such scientists as Professor and Madame Curie, Rudolf Diesel, Tolbert E. Lanston, Nikola Tesla, Tinius Olsen, and Roger Adams.

Professor Moody's award is given "in consideration of the leading part he has taken in the design and development of hydraulic turbines and pumps, the many patents issued to him, which have been widely used in practice, due to improvements in efficiencies, higher speeds, and better operating characteristics, and his valuable contributions to the theory of design in this field of engineering."

Van Pelt to Head Battelle's Research Education Program

J. R. VAN PELT, JR., has recently joined the staff of Battelle Memorial Institute Columbus, Ohio, and will head Battelle's program of research education. Dr. Van Pelt was until recently technical director of the Museum of Science and Industry, Chicago, Ill., and is noted for his educational pioneering.

HONORABLE SERVICE BUTTON

Honorable Service Button

MORE than a million veterans of the armed forces are now entitled to wear the Honorable Service Button which is issued to each individual on his discharge from the Army, Navy, Marine Corps, and Coast Guard.

While this button should entitle its wearer to the respect of Americans everywhere, the War Department is frequently informed that the public does not generally recognize the meaning of the emblem. Veterans with long combat service overseas, now returned to civilian life, have the unpleasant experience of being challenged for their failure to appear in uniform. Their badge of honorable service has not been recognized.

A photograph of the button is shown herewith.

Any veteran who has lost the button originally issued to him may obtain a duplicate at cost (seven cents) by presentation of his discharge certificate to the Quartermaster Supply Officer at any post, camp, or station, or by writing to The Adjutant General, War Department, Washington 25, D. C.

How to Buy A.S.M.E. Life Membership

MANY A.S.M.E. members are investing in Life Membership in the Society in these days when money is "cheap." There are many advantages in doing so. Not only is one assured of being able to enjoy his A.S.M.E. membership for life but for many engineers it is an excellent investment.

When a member pays dues year after year he is, in effect, purchasing an annuity which, at the end of 35 years, gains for him Life Membership without further payment of dues. This same member may buy a Life Membership outright at any time after his election by paying a lump sum. The cost is different in each case because it depends not upon only the number of years the member has already paid dues but also on his age. The following table shows how much a member must pay to purchase Life Membership if from 5 to 35 years must elapse before he is transferred to the non-dues-paying group.

In addition to the savings that can be made by purchasing a Life Membership as indicated in the table a member should consider what additional saving might be made in his income-tax payments. The amount saved of course would depend upon his net income, but it is an item that is certainly worth investigating. We quote from the United States Internal Revenue Code, Sec. 29.23(a)-5. "Professional expenses—A professional may may claim as deductions the cost of supplies used by him in the practice of his profession, expenses paid in the operation and repair of an automobile used in making professional calls, *dues to professional societies* and subscriptions to professional journals, the rent paid for office rooms

SCHEDULE OF RATES FOR LIFE MEMBERSHIP

Years to pay dues	Total dues paid at $20 per yr	Cost of Life Membership
5	$100	$95.24
10	200	179.42
15	300	253.82
20	400	319.58
25	500	377.70
30	600	429.06
35	700	474.47

the cost of the fuel, light, water, telephone, etc., used in such offices, and the hire of office assistants. Amounts currently expended for books, furniture, and professional instruments and equipment, the useful life of which is short, may be deducted."

Members who wish further information are encouraged to correspond with the Secretary and full details will be sent them.

A.S.M.E. Staff Pension Plan Approved by Letter Ballot

BALLOTS of members of The American Society of Mechanical Engineers on the adoption of a pension plan for members of the A.S.M.E. staff were canvassed on March 19 by the tellers, George L. Knight, William G. Christy, and J. J. Swan. The plan approved by the Council was also approved by the members.

The total number of ballots cast was 7291, of which 244 were defective. Of the 7047 valid ballots, 6779 were cast in favor of the plan and 268 against it.

I.I.T. to Establish Precision-Measurement Laboratory

HENRY T. HEALD, president, Illinois Institute of Technology, has announced an initial grant of $15,000 from the Ohmite Manufacturing Company, to be used for the establishment of a laboratory for the precision measurement of electrical and magnetic quantities. The gift came through David T. Siegel, president, Ohmite Manufacturing Company, and a trustee of Illinois Tech. It represents the initial contribution for equipping what will be known as the Ohmite Laboratory for Precision Measurements. It will be expanded constantly as new equipment becomes available.

The laboratory's ultimate goal is to provide precision electrical measurements for the Chicago area approaching in accuracy those of the Bureau of Standards in Washington, D. C.

A.S.M.E. Local Sections

Coming Meetings

Baltimore. May 28. Engineers Club of Baltimore, 6 W. Fayette St., Baltimore, Md., at 8:00 p.m. Subject: "Riverside Steam Station," by G. P. Fallon, G. S. Harris, and F. W. Quarles.

Chicago. May 14. Chicago Engineers Club, 314 South Federal St., Chicago, Ill., at 6:00 p.m. Subject: "Industrial Relations After the War," by Harold F. North, Director of Industrial Relations, Swift & Co., Chicago.

Central Illinois. May 11. Jefferson Hotel, Peoria, Ill., at 8:00 p.m. Subject: "Engine Turbosuperchargers," by an authority on the subject from the General Electric Co.

Cleveland. May 10. Ballroom of the Statler Hotel, Cleveland, Ohio, at 8:00 p.m. Subject: "Latest Developments in Rockets, Jet Propulsion, and Gas Turbines," by Lionel S. Marks, Harvard University, Cambridge, Mass. Dr. Marks is the A.S.M.E. Lecturer for 1944-1945.

Columbus. May 9. Battelle Memorial Institute, Columbus, Ohio at 8:00 p.m. Subject: "Latest Developments in Jet Propulsion and Rockets," by Lionel S. Marks, Harvard University, Cambridge, Mass.

Detroit. May 1. Engineering Society of Detroit, Detroit, Mich., at 8:00 p.m. Subject: "Electronics at Work," by three engineers of the Westinghouse Electric & Manufacturing Co. There will be a panel discussion, and the subject will be illustrated and demonstrated.

Erie. May 11. Erie County Court House at 8:00 p.m., Erie, Pa. Subject: "Latest Developments in Jet Propulsion and Rockets," by Lionel S. Marks, Harvard University, Cambridge, Mass.

Metropolitan Section. New York headquarters, 29 West 39 Street, New York, N. Y. May 7, Fuels Division 7:30 p.m., Room 501, "Experimental Study of Flow of Coal in Chutes," by H. F. Wolf and H. L. von Hohenleiten, Consolidated Gas Electric Light and Power Company of Baltimore, Md.

May 8, Management Division, morning and afternoon session, Room 501, "Quality Control Methods."

May 10, Petroleum Division 7:30 p.m., Room 501, "Design and Operation of Hot Catalyst Elevators Used in Thermofor Catalytic Cracking Units," by S. M. Mercier; "Mechanics of Flow in Fluid Catalytic Cracking Units," by H. P. Wickhan.

May 15, Power Division 7:30 p.m., Room 501, "Irreversibility in the Theoretical Regenerative Steam Cycle," by R. E. Hansen, Ebasco Service, Inc., New York, N. Y.

May 22, Inter-American Night, "Engineering and Industrial Horizons in Foreign Trade."

Washington, D. C. May 10. Potomac Electric Power Co. Auditorium, 10th and E Sts., N.W. Subject: "Turbine Locomotives," by J. S. Newton, assistant manager of engineering at South Philadelphia Works of Westinghouse Electric Co. Mr. Newton will discuss primarily the turbines that were designed for and installed in the new Pennsylvania locomotive.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

EXECUTIVE MECHANICAL ENGINEER, 42, extensive experience in planning and manufacturing methods, factory planning, and costs. Interested in locating in metropolitan New York. Me-900.

GRADUATE MECHANICAL ENGINEER with 20 years' experience as supervising engineer, including building construction, plant maintenance, and operation of power plants. Capable supervision large groups of men of all building and mechanical trades. Me-901.

GRADUATE MECHANICAL ENGINEER, graduated top rank American university, age 29. Four years' experience as assistant to chief engineer. At present at Cuban sugar mill. Thorough knowledge of Spanish. Cuban citizen. Alert, tactful, seek responsible position in Cuba. Experience in installing industrial-plant equipment. Available immediately. Me-902.

MECHANICAL ENGINEER, graduate M.I.T., licensed two states, age 52, 26 years' experience in plant maintenance, power, layout, construction; forces up to 500 men. Health excellent, good manager, organizer. Permanency desired. Me-903.

MECHANICAL-ELECTRICAL ENGINEER, 48; 25 years' experience design-purchase-construction-maintenance, steam and electric power facilities. Ten years executive in charge. Desire position with industrial, utility, or consultants with future. Me-904.

DEVELOPMENT ENGINEER. Results of independent investigation covering mathematical determination of factors governing properties of metals (critical temperatures, crystal structure, internal stresses, vibration, polarity, low-temperature qualities), data applicable to other materials and gases, available to company interested in development work; services available also on allied research, product and equipment development, plant operation, layouts and reports. Me-905.

POSITIONS AVAILABLE

FACTORY SUPERINTENDENT, under 40, for new plant employing 300–400 persons. Must be thoroughly experienced in shop practices, machine tools, and capable of handling men. Salary, $7500–$15,000 a year. Northern New Jersey. W-5147.

ENGINEER, mechanical, with experience on special machines used for spinning or formation of yarn filaments for design and development of improved machinery, equipment, and methods for producing rayon yarns. Permanent, good opportunity. Georgia. W-5148.

GENERAL MANAGER with dry-cell battery and flashlight-manufacturing experience to take charge of operation of new foreign plant. Salary, $10,000-$15,000 a year. India. Interviews, New York, N. Y. W-5155.

CHIEF ENGINEER for established firm, preferably specialist in heavy-machine-tool design, to design large grinding machine of new type and to build staff for extensive postwar operations. Salary, about $7500 a year. Eastern Pennsylvania. W-5159.

MECHANICAL ENGINEER, experienced with small mechanisms, for control-instrument engineering and design work. Salary, to $5400 a year. Wisconsin. W-5162.

ENGINEERS. (*a*) Industrial Draftsman for design and improvement of plant equipment and some project engineering. (*b*) Master mechanic with supervisory experience and general plant maintenance of mechanical and building equipment, preferably in the rubber industry. Location, Connecticut. W-4397.

SPECTROGRAPHER, CHEMIST, or PHYSICIST who would be interested in training in spectrography for position of responsibility in a light metals plant with a sound future. Good starting salary commensurate with applicant's training and work record. Location, Kentucky. R-2577-C.

ASSISTANT MATERIAL ENGINEER with metallurgical, engineering, or similar experience to assist in preparation of specifications and technical bulletins. Good postwar prospects for the right man. Location, Kentucky. R-2578-C.

FOUNDRYMEN (4), experienced, to start up and put into producing condition several foundries which have been damaged. Write stating complete experience outlining clearly different phases of foundry work which you understand and have performed. Will be investigated by War Department. Salary-$10,400 a year plus expenses. France. W, 5188.

PRODUCTION ENGINEER fully competent to study, start, and follow production on new projects for multiple-spindle screw machines and all round machine tools. Company is one of largest screw-machine companies, now working 100 per cent on war contracts with postwar future. Salary good. New York metropolitan area. W-5251.

MARKET RESEARCH ENGINEER who is experienced in industrial phase of sales research for company engaged in manufacture of starch and starch products for sale to industrial concerns. Man will do routine work of digging out from available literature and through interviews some of the information necessary for this work. Company now engaged in large and expensive program of sales research in connection with present products and new ones. Salary, about $5000 a year. New York, N. Y. W-5260.

DESIGN ENGINEER with experience on design of special-purpose electric machine welding equipment. Salary, $6000–$7500 a year. Chicago, Illinois. Interviews, New York, N. Y. W-5264.

ENGINEERS. (*a*) Staff engineer, mechanical graduate, with considerable experience in plant engineering in food or dairy industry, for executive position under production manager. Headquarters New York, N. Y. with some traveling. Salary, $7000–$8000 a year. (*b*) Plant engineer, mechanical graduate, with food or process industry experience, to plan and supervise improvements and plant additions. Salary, $3500–$4000 a year. New York, N. Y. W-5269.

ENGINEERS. (*a*) Mechanical engineer, graduate, with minimum of two years' experience qualifying him for preparation of designs, estimates, studies, and layouts of jobs including compressed air, heating, ventilating, plumbing, process piping, and production equipment. Maintenance, alterations, and new construction in large ordnance plant. Salary, $3900–$5100 a year. (*b*) Electrical or mechanical engineer, graduate, to make studies and reports on technical phases of department including heating, power and water facilities in large ordnance plant. On-the-job training with expectation of becoming assistant to utilities superintendent. Salary, $2700–$3900 a year. Western Tennessee. W-5277.

ENGINEERS. (*a*) Industrial engineer, 35–45, to head up department on production planning and control, particularly experienced in production planning on very heavy machine-shop operations. Salary, $7500–$8000 a year (*b*) Research and development Engineer, mechanical graduate preferred, with background and experience in heavy machinery such as paper-mill machinery and heavy centrifugals for chemical industry. Will be required to coordinate in the plant and study clients' problems in the field. Salary, $6500 a year. Massachusetts. W-5282.

ENGINEERS. (*a*) Senior project engineer, experienced. Will sit in on all product-manufacturing planning meetings, both to interpret the designer's ideas to production personnel and to protect design by being sure planned operations will give adequate quality. Act as liaison man between production and engineering. Salary, $5000–$7000 a year. (*b*) Assistant director of sales, under 40. Should be con-

[1] All men listed hold some form of A.S.M.E. membership.

versant with engineering involved in the application of unit heaters. Work will principally consist of sales engineering. Salary, $4200–$4500 a year. Upstate New York. W-5283.

DESIGNER, graduate preferred, by established manufacturer of sewage-treatment equipment located in Chicago. Experience in structures, piping, and mechanisms desirable. Postwar opportunity for development and sales engineering. Annual Salary, $3600. (*b*)

DRAFTSMAN, with some experience on piping and plant layout. Salary $200 per month. Send full particulars including availability. R-2529.

ASSISTANT CHIEF ENGINEER, graduate mechanical, for original design and supervision and maintenance in wood-preserving industry Experience in material-handling apparatus, conveyers, locomotive cranes, process equipment, such as steam-driven pumps of all kinds, pressure piping, boiler plants, vacuum apparatus, and woodworking plants essential. Some traveling required, perhaps 20 per cent of time for observing equipment, supervising maintenance work, and supervising installation of equipment at company's 25 plants. On some occasions, testing and critical engineering inspections of apparatus would be involved. Louisville, Kentucky. Salary, $5000 a year. R-2555C.

DESIGN ENGINEER, preferably 30–40 years old, graduate mechanical engineer, to design and lay out railroad truck suspensions, hydraulic and pneumatic devices. Knowledge of metallurgy and stress analysis desirable. Apply by letter. Salary open. Southern California. S-875.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after May 26, 1945, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALBERT, J. A., St. Louis, Mo.
BAECKLER, WALTER, Niagara Falls, N. Y.
BANISTER, GUY, Aurora, Ill.
BANKS, S. J. EGERTON, Canterbury, England (Rt)
BENSON, F. R., Newport News, Va.
BOGARDUS, FREDERICK J., Alexandria, Va. (Rt & T)
CAPA, GERMI, Istanbul, Turkey
CARMAN, EVERETT P., Washington, D. C.
CHILTON, ERNEST G., Akron, Ohio
CLARK, CLAUDE L., Canton, Ohio
CLARK, HENRY F., Youngstown, Ohio
CORBIN, SPOTSWOOD WELLFORD, Charlton, N.Y.
DAVIES, CHARLES, New Rochelle, N. Y.
DEAN, FRANCIS H., Normandy, Mo.
DRAKE, JOSEPH H., Jacksonville, Fla.
DUNLAP, RICHARD MORRIS, Cambridge, Mass.
EBERTH, W. F., Arlington, Va.
EDGE, WALTER C., Philadelphia, Pa.
EISENWINTER, ED. E., Watertown, Conn. (Rt)
FLOOR, ERIK, Chicago, Ill.
GARDNER, K. A., Freeport, N. Y.
GEORGE, GEORGE W., Cumberland, Md.
GOOD, PAUL F., Baltimore, Md.
GORE, ROBERT T., Middletown, N. J.
GRISWOLD, EDGAR A., Los Angeles, Calif.
GROTH, HANS F. A., Johnson City, N. Y.
GUERRERO, J. E., Dallas, Texas
HAILER, ALBERT J. (LIEUT.), San Francisco, Calif.
HANDA, C. L., Knoxville, Tenn.
HENDERSON, HENRY H., Cambridge, Mass.
HERMAN, RUDOLPH V., St. Clair Shores, Mich.
HERR, JOHN A., Hamden, Conn. (Rt & T)
HOELSCHER, R. P., Urbana, Ill.
ISENBERG, PAUL F., Roaring Spring, Pa.
JARCHOW, WERNER C., St. Louis, Mo.
KEHOE, D. E., Savannah, Ga. (Rt)
KELLER, W. M., Merion, Pa.
KIRKBY, NORMAN O. (LIEUT.), DePere, Wis. (Re)
KLEIN, ALFRED, New York, N. Y.
KRAUSS, HARRY E., JR., Upper Darby, Pa.
KRODER, ERNEST A., Bridgeport, Conn.
LAROCCO, MICHAEL J. (LIEUT.), New York, N. Y.
LATTAN, JEAN E., Oak Park, Ill.
LEBLANC, J. H., JR., New Orleans, La.
LERNER, MILTON E., Brooklyn, N. Y.
LILLY, CLYDE A., JR. (CAPT.), Fort Worth, Texas
LINSKER, EUGENE (LIEUT.), Salina, Kansas
LOW, JOHN R., JR., Pittsburgh, Pa.
MACK, T. R., Elizabethton, Tenn.
MARVIN, P. R., Milwaukee, Wis.
MAZZAGLIA, JOSEPH D., Flushing, N. Y.
MCCULLY, H. M., Allison Park, Pa.
MCWORKMAN, DELAMAR, Indianapolis, Ind. (Rt)
MEYERS, RICHARD EDWARD, San Francisco, Calif.
MORRISETT, O. L., Duncan, Okla.
MORRISON, B. W., JR., Concord, Mass.
MORSE, B. W., Ossining, N. Y.
O'HAGAN, R. S., Christchurch, N. Z.
MURRAY, V. F., New York, N. Y.
ORAN, SAMUEL, Chicago, Ill.
PARASO, BENEFICO F., Pearl Harbor, T. H.
PARK, FRANK C., Marietta, Ohio
PLANT, A. MORTON, New Haven, Conn.
POOLE, JOE A., El Dorado, Ark.
PROCHAZKA, F. J., Racine, Wis.
PUTNAM, J. A., Berkeley, Calif.
PYEATT, F. E., JR., Tulsa, Okla.
RANSDELL, C. H., College Station, Texas
REEVES, JERRY H., JR., Greenville, S. C.
RICHARDSON, CARL, Los Angeles, Calif.
RIDEOUT, WILLIAM M., St. Louis, Mo.
ROBINSON, KEITH E., Seattle, Wash.
ROBINSON, PARKER M., San Francisco, Calif. (Rt)
ROWE, G. THORNTON, Santa Monica, Calif.
SCHAAF, JULE W., Camden, N. J.
SEAHOLM, K. EINAR, Philadelphia, Pa.
SECOR, AMBROSE T., Chattanooga, Tenn. (Rt & T)
SMETTERS, SAMUEL T., Chicago, Ill. (Rt)
SMITH, BEN D., Indianapolis, Ind.
SPRAGUE, WILLIAM P., Dallas, Texas
STANTON, JOHN J., Boston, Mass.
STEINER, KALMAN, Baltimore, Md.
STONE, R. A., Cumberland, Md. (Rt)
SUCHY, GEORGE F., Waukesha, Wis.
THOMPSON, MAXWELL A., Big Creek, Calif.
TURNER, MEBANE E., Winston-Salem, N. C. (Rt & T)
UGUCCIONI, CLERIO, Chicago, Ill.
VOSE, RICHARD S., Swarthmore, Pa.
WAGNER, PAUL W., Trotwood, Ohio
WALKER, WILLIAM LLOYD, Los Angeles, Calif.
WERLEY, HARLAN R., Oaklyn, N. J.
WHITING, HAROLD W., Buffalo, N. Y.
WILLIAMS, CHESTER M., Los Angeles, Calif.
WILSON, C. M., University City, Mo.
WOMACK, H. S., St. Louis, Mo.
ZEGERS, VINCENT J., Chicago, Ill.
ZIRKEL, PAUL J., Fort Wayne, Ind.

CHANGE OF GRADING

Transfers to Fellow

HOWARD, ERNEST E., Kansas City, Mo.
LARKIN, FRED V., Bethlehem, Pa.
OATLEY, HENRY B., Great Neck, N. Y.
SCHAFF, F. A., New York, N. Y.
STUART, MILTON C., Bethlehem, Pa.

Transfers to Member

BARIFFI, HERBERT F., Hamden, Conn.
BAUMAN, J. ARTHUR, Brooklyn, N. Y.
BECHTEL, LUTHER D., Chicago, Ill.
BROWN, T. C., Raleigh, N. C.
DAHLUND, E. L., Beloit, Wis.
DOCKSTADER, ERNEST K., Waynesboro, Va.
HIRSCH, JOSEPH, Brookline, Mass.
HUTCHINS, W. E., Montclair, N. J.
MACOMBER, THOMAS W., Berkeley, Calif.
PRO, GEORGE M., Kansas City, Mo.
RACHALS, RICHARD, New York, N. Y.
SILVERMAN, HARRY THOMAS, Gary, Ind.
THURMAN, A. L., Schenectady, N. Y.
WILKINSON, GEORGE D., JR. (CAPT.), Arlington, Va.

Transfers from Student-Member to Junior 51

A.S.M.E. Transactions for APRIL, 1945

THE April, 1945, issue of the Transactions of the A.S.M.E. contains:

10,000-Kw Railway-Mounted Mobile Steam Power Plant for U. S. Navy Department, Bureau of Yards and Docks, by Edwin Lundgren and L. R. Biggs

Locomotor Mechanics and Occupation, by A. Steindler

Lubrication Characteristics of Involute Spur Gears, by E. K. Gatcombe

Relation of Surface-Roughness Readings to Actual Surface Profile, by L. P. Tarasov

Carry-Over in Locomotive Boilers, by Arthur Williams

On Fatigue Failure Under Triaxial Static and Fluctuating Stresses and a Statistical Explanation of Size Effect, by F. H. Fowler, Jr.

• Keep Informed . . .

Announcements in this section are supplied by current advertisers in MECHANICAL ENGINEERING and A.S.M.E. MECHANICAL CATALOG. This section is restricted to these advertisers.

- *NEW EQUIPMENT*
- *BUSINESS CHANGES*
- *LATEST CATALOGS*

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

Lever Type Cutter for Wire Rope

The T. H. Lewthwaite Machine Co. of New York City have recently added to their line of hand-operated, metal-working tools a lever type cutter for wire rope.

This machine has the simple design and durable construction that are characteristic of their tools. It works on a front lever, pinion movement. Extensive tests were conducted before it was offered for general sale to determine its most effective capacity. It is now made in two capacities: One for cutting 1″ and smaller wire rope and one, with a small constructional change, for cutting $1^1/_4$″ and smaller wire rope. The blades are made of a special alloy tool steel for extra toughness and correspondingly longer wear. Its compactness and weight of about one hundred and ten pounds make it easily portable. Further information will be furnished on request from the T. H. Lewthwaite Machine Co., 315 East 47th Street, New York, 17, N. Y.

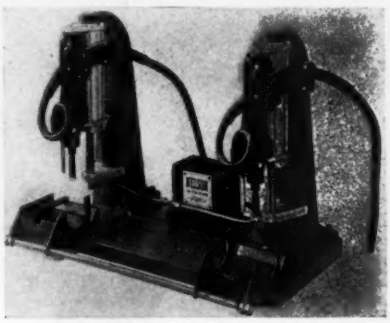
New Combination Blueprint Pencil

Eberhard Faber has just announced an innovation in their No. 650 Van Dyke Blueprint Pencil, which is a standard seven inch length and contains a red lead at one end and a yellow at the other. This dual purpose pencil should fill a long felt need in drafting rooms. Because of its time saving feature, it is particularly adaptable for engineers, architects and designers. Ideal for making notations and corrections in red or yellow on blueprints. Packed $^1/_4$ gross in a carton.

Nelson Multiple Stud Welder Production Unit

A new automatic stud welding development to meet mass production requirements is the Nelson Multiple Stud Welder Production Unit. Using this unit two or more studs may be welded in one operation. The work is rapidly performed and the studs are held to very close tolerances.

Each of the welding guns is mounted on a pneumatic air cylinder. Each cylinder is fixed to a movable arbor which can be adjusted to any spacing necessary for the work.



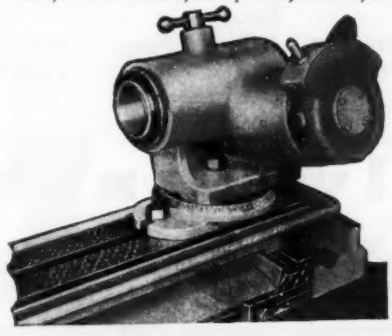
The work is held in a mandrel, chuck, or special locating device—the setup being determined by the particular production problem at hand. The welding current is obtained from a conventional "Nema" 400 amp. generator, and is regulated by a timing control unit which automatically controls the length of arc flow, producing controlled and consistent welds.

The Multiple Welding Unit is operated with a single control switch. The work is located, stud is fitted into the chuck of each stud welding gun, and the control switch pressed. The first gun then descends making a weld. Upon completion of this weld the next gun descends and welds. The guns then ascend automatically and the work is removed.

Each production unit is manufactured only on order to permit the unit to be made to fit the particular problem. For complete details and prices write Nelson Specialty Welding Equipment Corp., 440 Peralta Avenue, San Leandro, Calif.

Motor Driven Work Head

The K. O. Lee Co. of Aberdeen, South Dakota is now in production on a newly designed Motor Driven Work Head. This compact, self-contained power unit is built for use on any make of grinder, large or small. It is constructed with No. 11 B&S tampered spindle, mounted on ball bearings, hardened and ground, and is designed to receive chucks, collet fixtures, face plates, centers, etc.



The built-in Universal motor is provided with conveniently located reversing switch, regardless of the position of the work table or rotation of the work. The motor is fully protected from dust and from any oil entering from working parts. The unit is quickly and easily mounted and is held in position by two T-slot bolts at any convenient spot on the table.

The fixture is mounted on a detachable swivel base which is graduated in degrees (45 degrees either side of center) and permits full 360 degrees swivel if desired. Swing over table, with swivel base $8^1/_4$″; without swivel base $6^1/_4$″. The unit measures 7″ in width, $6^1/_2$″ in length and $7^3/_4$″ in height and weighs $20^1/_2$ pounds.

On 24-hour per day production work or for tool room maintenance work, this grinder fixture will prove one of the most worthwhile units in your plant. New, illustrated literature is just off the press and will gladly be sent on request. Write for bulletin No. 33WH.

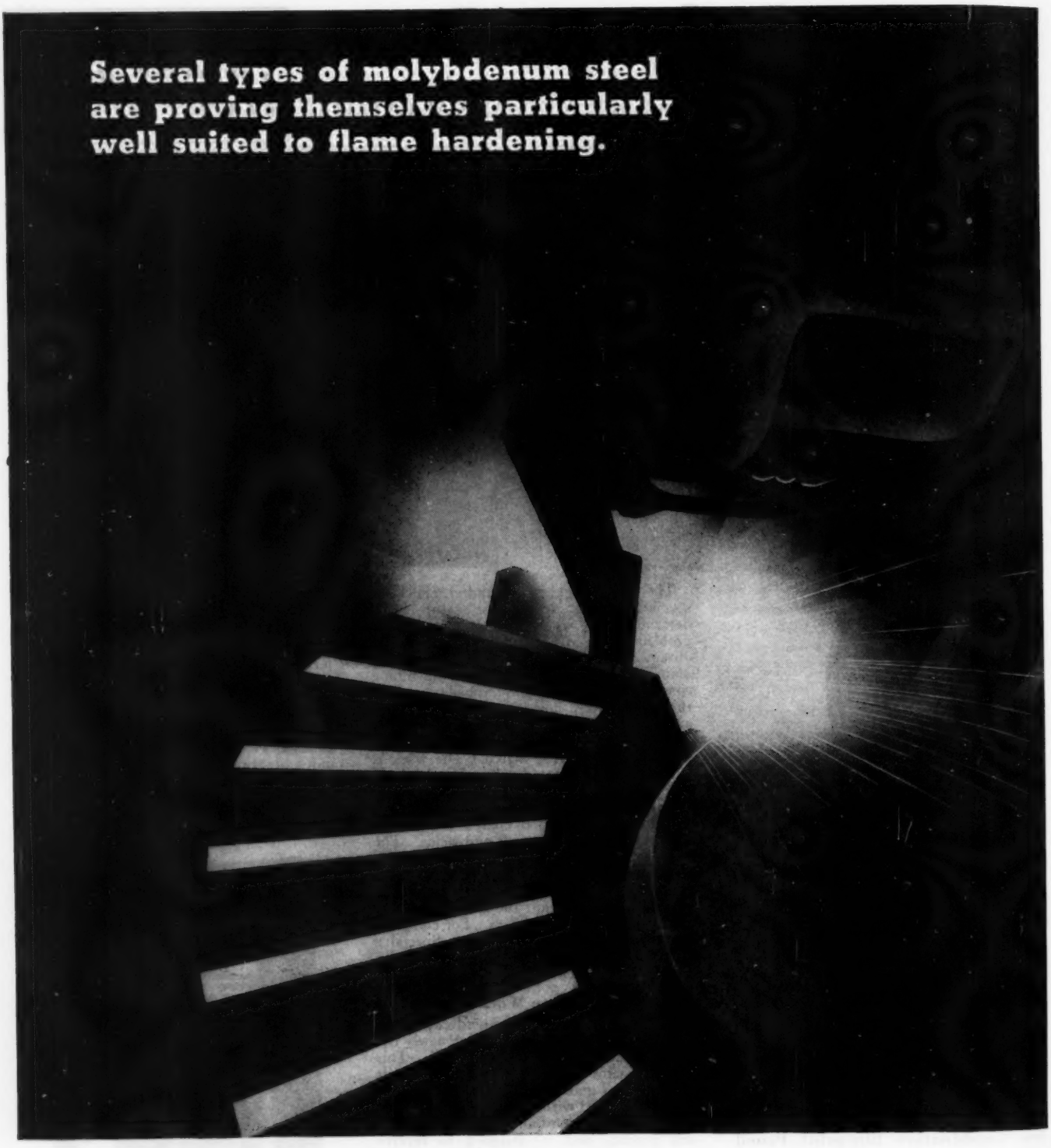
Bruning Announces New Model 41 Printer-Developer for Making Black and White Prints

Designed to provide simple, economical and efficient printing and developing facilities for those who require Black and White Prints in medium quantities, a new BW printing and developing machine, known as the Model 41, has just been announced by the Charles Bruning Co., 4754 Montrose Ave., Chicago 41, Ill. This new model combines individual printing and developing units in a modern cabinet of pleasing appearance, with a sturdy, all steel frame of box girder construction for maximum rigidity, alignment and stamina.

The Model 41 Printer has a printing speed range up to 6 feet per minute, depending on the transparency of the original, printing either roll stock or cut sheets, with a printing width of 46 inches. The light source is a 2,000 watt glass mercury vapor lamp within a 6-inch diameter cylinder—uniform distribution of light is assured over the entire printing area of the cylinder. An entirely new method (patent applied for) of cooling pulls air into and through the cylinder and contact bands, resulting in minimum machine temperature. Uniform cylinder temperature within a few degrees is maintained, thus assuring uniformity of print exposure. Air is

Continued on Page 29

Several types of molybdenum steel are proving themselves particularly well suited to flame hardening.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Ave. • New York City

MOLY

• Keep Informed

sucked in at the front of the machine as well in order to provide greater comfort for the operator, as well as maximum cleanliness.

Printing speed is controlled by a single knob, easily-read dial, located within convenient reach of the operator. Suction through the bands simplifies feeding of tracings and sensitized paper and the tangential method of feeding assures safety to the tracings and eliminates pinching or catching. Tracings and prints are removed without scraping, thus insuring long cylinder life. A front pedal located at floor level and at the center of machine, instantly releases band tension so that mis-feeding of roll stock can readily be corrected.

The printing unit is extremely simple in its mechanical structure to provide long and trouble-free service. Anti-friction bearings, easily lubricated, are used throughout. The ball bearing motors require no lubrication and the cylinder is easily accessible for cleaning. All wiring conforms to rigid quality and safety standards.

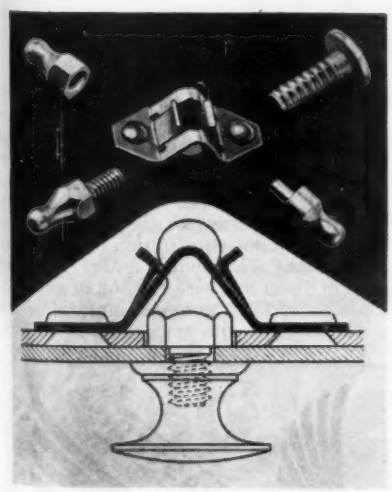
In the developing unit, speed in excess of maximum printer speed assures an uninterrupted flow of prints. Prints are delivered at front of the machine, within easy reach of the operator. A new type ironing roll results in flat, dry prints.

Speed, contact and development controls are quickly removable for cleaning and all parts in contact with the developer are of stainless steel or are non-metallic.

Mounted on four sturdy casters, the printing-developing unit can be moved to and operated in any desired location. No plumbing connections are necessary and there is no need for outside outlets for exhaust fumes, because there are none.

In describing the Model 41 Printer-Developer, Bruning officials stated that it is intended to meet the needs of a wide range of users who wish a medium-priced machine of high quality, built for long and rigorous service.

New Spring Steel Latch



The new spring steel Speed Nut Latch No. 1663 has been developed for instant attachment and removal of box covers, access doors, panels and inspection plates. The spring arms of the Speed Nut snap over ball or grooved studs to provide firm attachment, yet studs may be quickly withdrawn. The Speed Nut is available in five material thicknesses to provide the desired degree of pull-out tension. Three styles of ball studs are available. . . drilled and tapped for 6-32 screws, threaded shank (6-32 thread) and

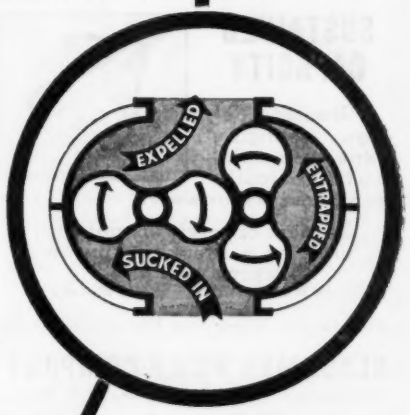
Continued on Page 30

Better Performance - Lower Power Costs

Through simple design, sturdy construction, and skilled workmanship, wear and maintenance have been reduced to a marked degree in Roots-Connersville Rotary Positive Vacuum Pumps. The positive displacement principle, coupled with moderate speed and high volumetric efficiency, assures suction wanted, with lowest power consumption.

"R-C" Vacuum Pumps are extensively used on vacuum filters because of their ability to handle air or gas and liquids in varying proportions. Their simplicity, positive action, and absence of all valves offer many advantages.

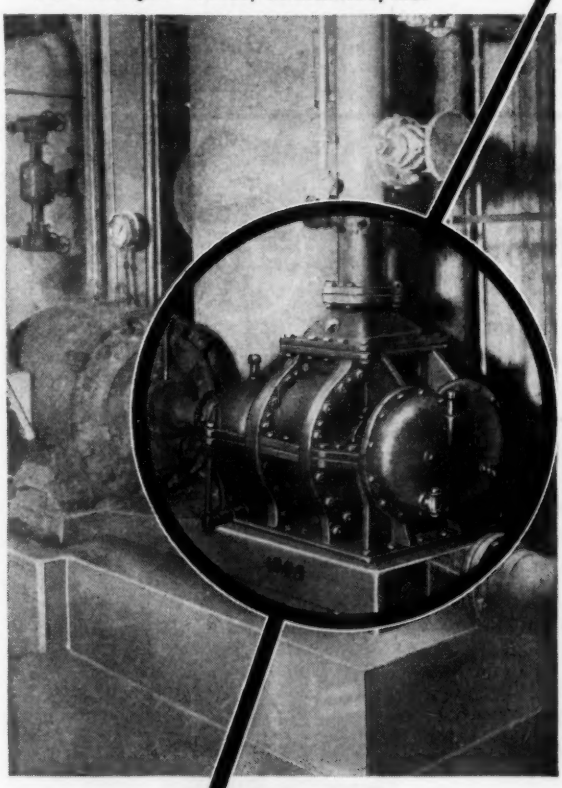
Capacities from 5 to 10,000 CFM, vacuums up to 25″ Hg.



ROOTS-CONNERSVILLE BLOWER CORP.

One of the Dresser Industries

505 Michigan Avenue, Connersville, Ind.



POSITIVE DISPLACEMENT

The principle is simple and effective. Twin impellers are rotated in opposite directions by a pair of timing gears. Each impeller alternately sucks in, momentarily entraps, and then expels a definitely measured amount of air or gas, resulting in the evacuation of four equal, predetermined volumes each revolution of the drive shaft. Capacity varies with the speed. Impellers need no seal or lubrication. Suction is automatically built up to overcome resistance on the inlet or vacuum side. The action is continuous, with a resultant steady vacuum.

•

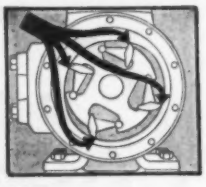
"R-C" Vacuum Pump installed in chemical plant. At 870 RPM it maintains 25" Hg. vacuum; handles 52 lbs. ammonia liquor, 1,465 lbs. water with trace of caustic soda, and 6,000 cu. ft. of "free air" per hour.

Write for your copy of Bulletin 50-B-12

Roots CONNERSVILLE SINCE 1854

Rotary Positive VACUUM PUMPS

DEPENDABLE PUMPS for
DEPENDABLE MACHINES & PROCESSING EQUIPMENT
BLACKMER ROTARIES
are
SELF-ADJUSTING FOR WEAR
SUSTAINED CAPACITY



"Bucket" design (swinging vane principle) automatically compensates for wear.

20 years of service is not unusual for a Blackmer pump.

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1920 Century Ave. Grand Rapids 9, Mich.
Capacities to 750 GPM Pressures to 500 psi

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plain shank for riveting. These, as well as the grooved stud are provided in various lengths to suit application requirements. When writing for samples, please specify (a) pull-out tension required ($3^1/_2$, 8, 12, 18, or 30 lbs.); (b) thickness of panel to which Speed Nut will be attached, (c) type of stud, and (d) length of plain or threaded shank, or length of grooved stud. Manufactured by Tinnerman Products, Inc., 2124 Fulton Road, Cleveland 13, Ohio.

Wheelabrator Swing Table Available in Four Sizes for Metal Cleaning and Finishing Requirements

With the addition of several new models to the line of Wheelabrator Swing Tables, manufactured by American Foundry Equipment Co., 555 South Byrkit Street, Mishawaka, Ind., industries having a moderate production covering a wide range of work to be cleaned are replacing compressed air blast rooms with these units. The Wheelabrator Swing Table, which utilizes the Wheelabrator airless abrasive blasting unit, extends the speed and economy of airless blast cleaning to a wide range of intricate or irregular shaped work formerly cleaned in air blast rooms in jobbing foundries and other metal working plants.

Four sizes of this blast cleaning machine are now available with sizes of the single work table being 24", 66", 72" and 86" in diameter. Operation of the four units is essentially the same, the machines varying only in minor construction details and number of Wheelabrator units utilized.

Work to be cleaned is placed upon a rubber-covered work table which is mounted on the door of the blast cabinet. As the door is closed, the work table swings into the cabinet underneath a Wheelabrator airless blast unit. While in this position, the table is rotated at a predetermined speed. The Wheelabrator unit whips a continuous stream of abrasive down upon the rotating work to the full width of the table so that all surfaces are uniformly blasted to a bright, clean finish.

Only a very short exposure of the parts to the Wheelabrator unit is required to clean the exposed surfaces thoroughly and uniformly. The Wheelabrator unit is then stopped, the door is swung open and the part is turned over for cleaning on the underside.

After striking the work, the abrasive falls through perforations in the table top into a hopper below the machine. A screw conveyor transfers the abrasive to the elevator boot section from which it is carried to an overhead abrasive separator. All broken down abrasive and useless fines are removed and the usable abrasive falls into a storage hopper for reuse.

One of the most important features of the Wheelabrator Swing Tables is that all blast cleaning operations are within the cabinet; the operator is never exposed to the abrasive blast or dusty conditions inherent in airblast room cleaning.

A number of these Wheelabrator Swing Tables have already been installed for cleaning products such as gray iron castings, furnace parts, gun carriage weldments, mine hoist castings, and a score of other pieces.

New Acco-Loc Safety Splice

American Chain & Cable Co., Inc., Bridgeport, Conn., announces the development of a new method for splicing preformed wire rope into slings or various assemblies—a method which renders hand-tuck splicing obsolete and unnecessary.

This method develops a neater and more compact splice than is possible by the hand method. The splice is flexible clear to the terminal, and always develops 100% of the rope's strength. The "Acco-Loc Safety Splice" does not distort the rope structure and so maintains equalization of stresses in all strands. The splice applies the load stress in direct line with the pull of the load. It has no seizings to loosen, unravel or get in the way; no wire ends to barb and tear

For the Safety of SHIPS . . .

America needed ships . . . 50,000,000 tons of cargo, tanker and transport ships, in addition to a vast fleet of Naval vessels—*and all of these ships needed safety valves, relief valves, and pressure gauges!*

Where did all these valves and gauges come from? Lonergan produced a lot of them . . . thousands of tons of them . . . and did so in addition to serving many of America's other vital war industries.

The facilities and 73 years of "know-how" that made possible this production achievement are at your service whenever you need *Safety Valves, Relief Valves,* or *Pressure Gauges.* Get Lonergan recommendations on your next inquiry.

J. E. LONERGAN COMPANY
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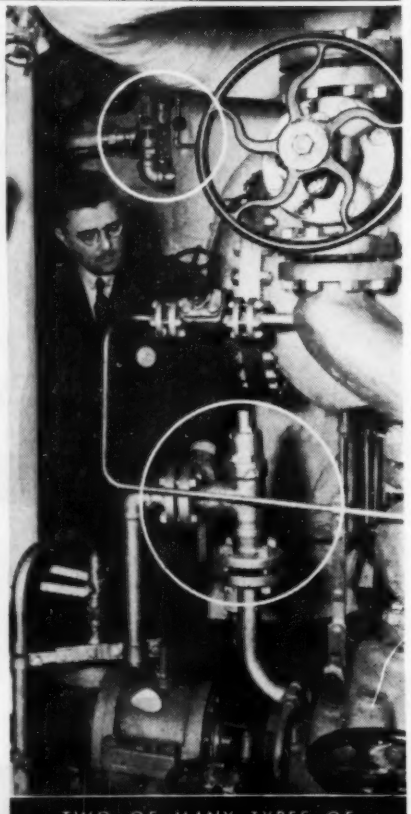
Safety Valves • Relief Valves • Pressure Gauges
SINCE 1872 — Makers of Pressure-Safety Appliances for the Power, Mechanical, and Process Industries



TWO OF MANY TYPES OF LONERGAN RELIEF VALVES USED ON SHIPS
OFFICIAL U. S. NAVY PHOTO

USE LESS··SO OUR FIGHTING FORCES WILL HAVE MORE!

LUBRIPLATE
No. 105

This very smooth, light density (semi-fluid) grease type lubricant resists water and other unfavorable operating conditions to a marked degree. LUBRIPLATE No. 105 not only provides superior lubrication but offers utmost protection against rust and corrosion. Because of its waterproof feature and freedom from "drag", it is ideal for

General Industry	Firearms
Radio Equipment	Outboard Motors
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LUBRIPLATE
Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE
Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE
Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.

Write for a booklet, "The LUBRIPLATE Film" written especially for your industry.

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FISKE BROTHERS REFINING CO.
NEWARK 5, N. J.
TOLEDO 3, OHIO
OUR 75TH YEAR
1870-1945
DEALERS FROM COAST TO COAST

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workmen's hands. It is wide open for visual inspection at all times. It may be used with any standard fitting (hook, ring, shackle, thimble, etc.), and when the sling or assembly is retired such fittings may be salvaged and re-used. At the present time the new "Acco-Loc Safety Splice" can be applied only at the factory.

Multi-Purpose Welding Positioner Introduced

The latest design in powered Welding Positioners is introduced by the Standard Machinery Co. of Providence, Rhode Island, for rotating work up to 700 lbs. at speeds from 0 to 2.4 RPM in either direction by easy hand wheel control. The unit will accommodate table speeds up to 180″ per minute with a work radius of 1′. Linear speeds at all radii are easily set and indicated on scale located on side of frame.

To obtain a desired welding speed it is only necessary for the operator to note the approximate radius at which the welding is to be done and to move the control wheel until the indicator is opposite the desired welding speed in the scale column for that radius. For sequence or step welding the table may be positively started, stopped or reversed.

The machine has proven adaptable for moving work past the torch and quench in flame hardening operations. The table can be removed easily and various jigs attached directly to the spindle. Also, the work mounted on positioner table may be tilted to any angle—permitting worker to operate at one position and so facilitate the inspection of parts or assembly operations.

While the table is originally designed for use as a support for parts to be welded and is only 28 inches in diameter, it may be utilized also as a basis of power in moving fixtures and work across machine tool tables in sequence operations.

The Positioner is provided with a new built-in "Standard" Variable Speed Transmission and hydraulic cylinder for definite power control with a single ½ HP, 110, 220 or 550 volt electric motor. There are no belts or clutches. Instantaneous starting, stopping and reversing is provided by a foot operated switch controlling the driving motor.

Height of the table is adjusted between 30″ and 36″ from the floor by means of its elevating screw. Hand operation of a latch permits rotation of the screw with respect to its supporting sleeve, in a manner similar to the raising or lowering of a piano stool.

Continued on Page 32

LUBRIPLATE
No. 107

Industry, especially food packers, have long required a waterproof lubricant that was clean and easy to apply. LUBRIPLATE No. 107 is the answer. It is a general purpose lubricant, white in color and just the right density for application by pressure guns or grease cups. LUBRIPLATE No. 107, like other LUBRIPLATE products, arrests progressive wear, saves power, and protects machines against rust and corrosion. It will pay you to try LUBRIPLATE and see how it will cut down repairs.

Rx FOR YOUR MACHINERY

No. 3—Ideal for general oil type lubrication. Ring oiled bearings, wick feeds, sight feeds and bottle oilers.

No. 8—Because of its high film strength and long life reflects outstanding performance in most types of enclosed gears (speed reducers).

No. 107—One of the most popular grease type products for general application by pressure gun or cups.

No. 70—For a wide range of grease applications, especially at temperatures above 200 degrees F.

No. 130-AA—Known nationwide as the superior lubricant for open gears, heavy duty bearings, wire rope, etc.

BALL BEARING—This is the LUBRIPLATE lubricant that has achieved wide acclaim for use in the general run of ball and roller bearings operating at speeds to 3000 RPM and temperatures up to 300 degrees F.

Write for a booklet, "The LUBRIPLATE Film" written especially for your industry.

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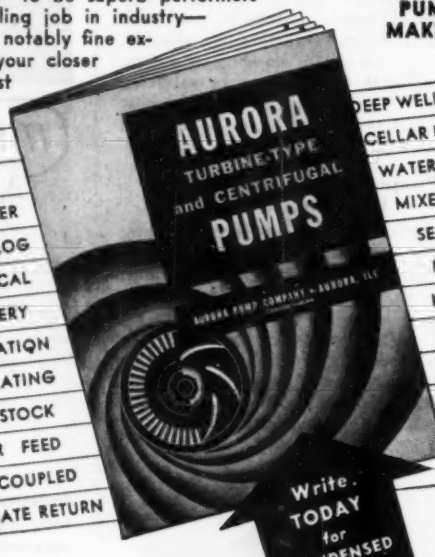

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For strength and simplicity, only two parts are used — bearing bars which carry the load and have curved slots punched ABOVE THE NEUTRAL AXIS, and cross bars, of the same cross sectional area as the slot itself, pressed into these slots to distribute the load. No rivets, bolts or welds are required, thus eliminating the possibility of loose joints. Tri-Lok flooring comes in rectangular, diagonal and U shapes with Safety Steps — ask for Bulletin 1140 — DRAVO CORPORATION, NATIONAL DEPARTMENT, 300 Penn Avenue, Pittsburgh (22), Pa. (Distributor for THE TRI-LOK COMPANY)

DRAVO

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The table is tilted by means of a hydraulic cylinder and gear segments. The oil pressure is developed by utilizing the gears that synchronize the disc drive rolls of the transmission. When not required for tilting, oil from the pump flows continuously at reduced pressure to lubricate and cool the drive roll shaft anti-friction bearings.

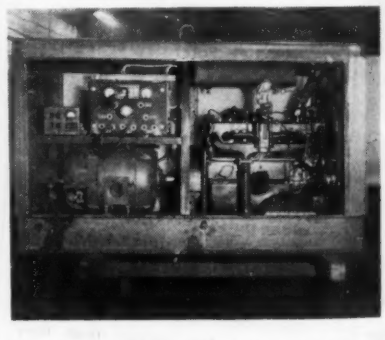
Tilting of the table through 135° from the horizontal is controlled by a spring-centered handle which the operator moves through an angle of approximately 45° in the direction of the desired table movement. Automatic limit stops are provided.

The mechanism of the machine is enclosed entirely for safe operation. There are no exposed gears. All moving parts are protected against splash from molten weld rods.

The "Standard" Welding Positioner is 32" long (without motor dimensions) 39½" long (overall with motor), 19" wide and weighs 665 lbs. The table is 28" in diameter, ⅝" thick and rotates on an elevating screw of 2" diameter.

300 Ampere Combination Welder and Power Unit

The 300 ampere Welder, made by Electric Arc, Inc., 162 Jelliff Ave., Newark, N. J., has a range of 50 to 400 amperes, with 450 amperes for intermittent uses such as cutting, for a short period, and by means of AC collector rings 3 KW AC standard 60 cycle auxiliary power is taken off for lights, drills, grinders and the various tools which the army and the general maintenance public finds useful. For instance, for post war this set will power a machine shop and light a machine shop; or power a mobile maintenance unit or a mobile combination welding and maintenance unit.



The lights are not affected by the welding, neither is the welding affected by the lighting and the engine is large enough to drive both at once without loss of voltage or frequency. This is the nicest model we have ever put out. It contains all the improvements in engine and generator that all the engineers of the country could think up to put in the specifications.

American Chain & Cable Announces All-Green Wire Rope

Wire rope that is entirely covered with a green-colored lubricant has recently been announced by the American Chain & Cable Co., Bridgeport, Conn., for their two wire rope divisions, the American Cable Div. and the Hazard Wire Rope Div. Only their highest grade rope (preformed of improved plow steel) will be so lubricated. Their non-preformed ropes made of improved plow steel will continue to be identified by a single green strand.

American Chain & Cable has long identified its ropes made of improved plow steel with a single green-colored strand. Emerald-green having been adopted as the ACCO

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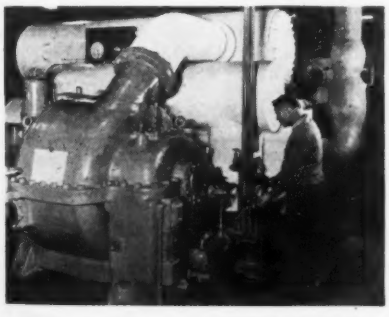
color, American Chain & Cable established a formula for a superior lubricant colored green for use as its identifying strand. That this green lubricant was definitely superior to ordinary black lubricants has been proved by years of field service. Ropes having the green strand, retired from all manner of service and returned to the mill for inspection and testing, revealed that wires protected with the green lubricant were in far better condition than the wires under the black lubricant in adjacent strands.

American Chain and Cable's "Green-Lube" has high viscosity and remarkable capacity for adhesion to the surfaces of the wires. It has a grease-like consistency at normal temperatures and is applied hot and in a molten state by the pressure method which not only assures complete coverage of every wire but the filling or "stuffing" of the voids between wires. Thus it better protects the wires, enables them to adjust themselves more easily, adheres to the wires longer and thereby develops longer rope wear.

Air Conditioning Speeds Output in Strategic Bearing Industry

Philadelphia, Pa.—To protect high precision accuracy in vital bearing plants, SKF Industries here now uses air conditioning equipment with a capacity of 24,000,000 cooling units or 2,000 tons of refrigeration.



Installed by York Corp. engineers in the company's three plants including a new windowless blackout plant, the air conditioning is vital in safeguarding production of tons of bearings a day ranging in size from the diameter of a dime to six feet. A total of 550,000 cubic feet of cool, filtered air a minute is circulated through the plants by means of a chilled water system and electrostatic air cleaners.

Air conditioning at SKF performs four essential jobs, all aimed at improved production and a reduction of spoiled parts. They are: 1. Helping to prevent stain-producing humidity from attacking finely finished bearing parts, or assembled bearings during handling, in assembly and final inspection. 2. Helping to maintain accurate dimensional controls not affected by varying outdoor climate conditions. 3. Keeping factory atmosphere free from lint and dust, dirt, vapor and grinding grit which normally collect on the oiled surface of bearing races, balls and rollers. 4. Preventing excessive summer temperature from increasing workers' fatigue and lowering efficiency and morale.

The smallest of several thousand different bearings made at SKF are ground to a surface finish accurate to one millionth of an inch, about the same thickness as the film of moisture left by breathing on a mirror. Even a microscopic bit of moisture, such as perspiration on the hand, will attack the surface of a bearing and eat into its finish in time. Once in contact with the polished steel, it cannot be easily removed and the corrosion will continue until the bearing is repolished.

Continued on Page 34

TIGHT VALVES *Save Fuel!*

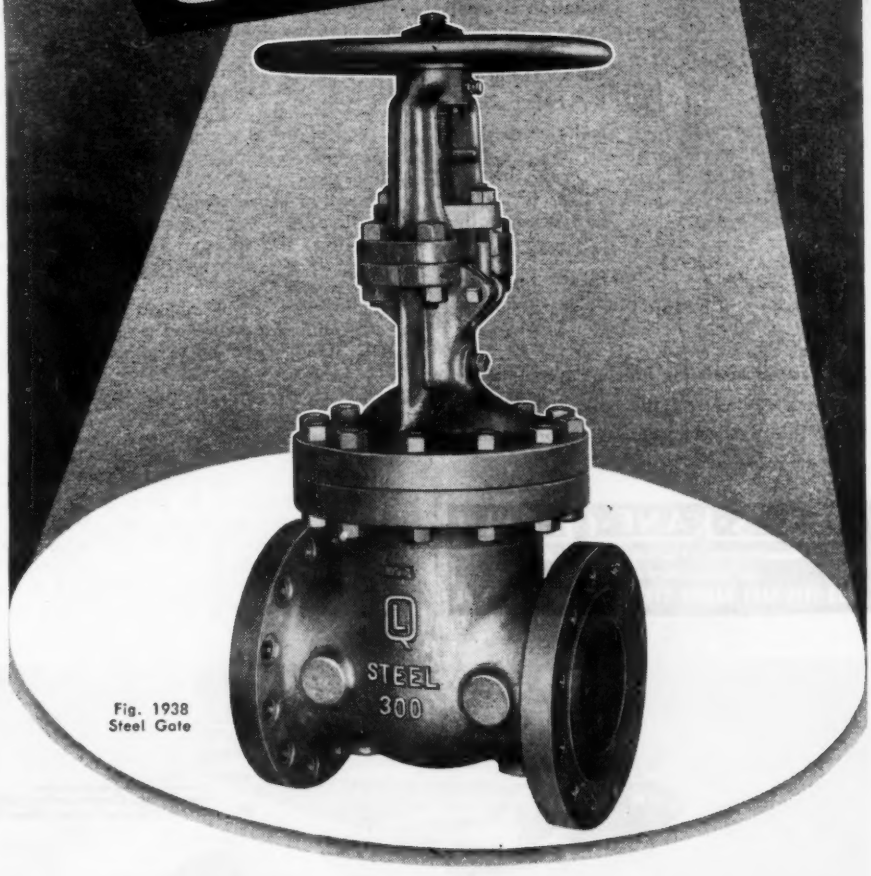
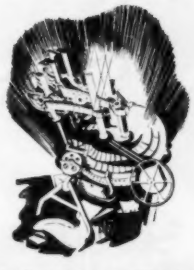


Fig. 1938
Steel Gate

...VITALLY IMPORTANT NOW, WHEN EVERY POUND MUST BE CONSERVED...



"MAN-MADE INFERNO"

From this huge electric furnace, large quantities of molten steel are poured daily, for use in making castings for Lunkenheimer Steel Gate Valves . . .

Many elements in a piping system may contribute to ultimate fuel waste. Insulation may be inadequate. Piping and fittings may be defective. Or *valves may fail to hold tight* . . . resulting in leakage of steam, air or water, and in lowered pressures, all of which may mean *excessive fuel consumption.*

Lunkenheimer Valves—whether of steel, iron, or bronze—are *quality built to stay tight,* over years of service. They afford constant, dependable protection against leakage. Simplicity of design and a minimum of working parts assure extra long life and easy, economical maintenance.

We have prepared a chart, showing in dollars-and-cents figures, what leaky valves can waste in steam, water, and air. For your copy, write to The Lunkenheimer Company, Cincinnati 14, Ohio, U. S. A.

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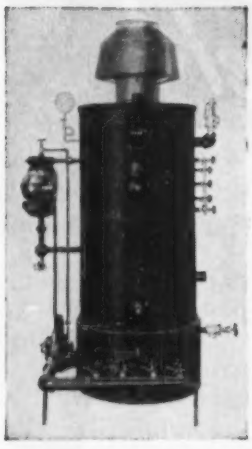
For today...

and for Post war



Bring us your post war problems for boiler work. . . our engineering consultation is available at all times.

The famous KANE, automatic, gas-fired . . . has everything you want in a steam boiler in sizes to 30 H. P. Engineers particularly will be interested in its scientific design.

The desired operating pressure is maintained by a patented double diaphragm valve which throttles gas input in exact proportions to steam demands.

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Manufacturers of Automatic Steam Boilers for over a third of a century.
1903-1915 EAST HAGERT STREET, PHILADELPHIA 25, PA.

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To guard against this before air conditioning was installed, SKF bearings carried a heavier coating of oil to protect them during handling. But this protection in itself created another hazard. The customary dust, grinding grit and haze in factory air collected more easily on the heavier oiled surface and threatened to cause destructive abrasions on the bearings when they were put in use in high speed operations occasionally as fast as 50,000 r.p.m. In addition, infinitesimal quantities of grit and dust on the bearings made size gradings complicated.

In the new windowless blackout plant of the company near Philadelphia, the entire manufacturing, assembly and inspection areas are kept at a constant temperature of approximately 80 degrees and a humidity of 45 per cent. All three of the SKF plants have two inches of roof insulation and steam coils to balance temperatures in winter. Condensers are located in roof top water coolers which depend on cold air alone during winter weather.

Electrostatic air cleaners in the critical assembly and inspection operations filter out nearly 100 per cent of all smoke, haze and dust particles delivering an atmosphere equivalent in purity to that found only at extremely high altitudes of the world.

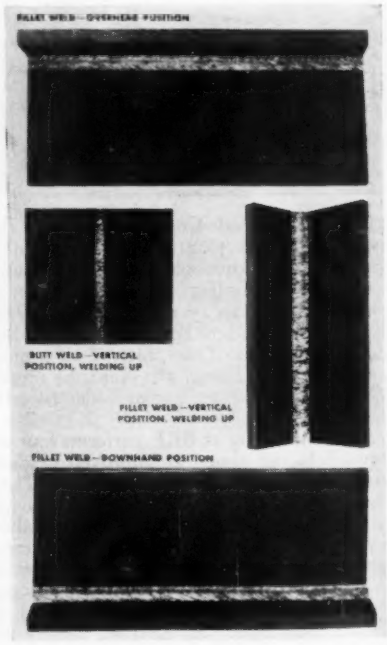
To maintain moisture, temperature and purity control over the air, 4,000 gallons of chilled water are poured into air washers at 43 degrees and leave at 55 degrees. Altogether 11 separate Freon "11" centrifugal water cooling systems are at work in the new plant air conditioning a total area of 379,200 square feet. Each of the systems includes a fan, washers, heating coils, air cleaning apparatus and automatic controls supplied by three 500-ton compressors and one 400-ton compressor.

At SKF Plant #1, a similar water cooling system of 105-ton capacity air conditions 16,200 square feet of space with 30,000 cubic feet of air a minute in assembly and final inspection departments on bearings. Two 60-h.p. Freon "12" compressors are used. One electrostatic air cleaner handles the filtering. The third plant equipped by York, the Atlas Ball Bearing final inspection Plant #2, conditions 12,800 square feet of space with a 325 h.p. Freon "12" compressor and an electrostatic air cleaner.

Before controlled indoor weather was installed at SKF, summer temperatures rose as high as 94 degrees making painstaking inspection and assembly work for women almost intolerable. By dropping these peak temperatures 15 to 20 degrees and maintaining a constant low humidity, general plant efficiency and morale has been increased in all departments. In addition, the technical problem of excessive moisture on the hands of operators has been largely eliminated and the heavy oil film formerly used on the bearings has been reduced to a point where it is barely visible to the naked eye.

New All Position Welding Electrode

A new shielded arc electrode for general purpose welding of mild steel which offers a number of outstanding advantages over existing electrodes of the same classification is announced by The Lincoln Electric Co., Cleveland, Ohio.



The new electrode, designated as "Fleetweld 47," offers such advantages as extremely low spatter loss, easy slag removal (most welds are practically self-cleaning) excellent re-striking characteristics, and other improved features.

Illustration shows specimen welds with the new Lincoln "Fleetweld 47" shielded arc electrode.

"Fleetweld 47" conforms to American Welding Society electrode specifications Class E-6012 and E-6013 and may be used with either alternating or direct current. "Fleetweld 47" is especially well suited for making high speed horizontal or flat fillet welds over 4-inches long in which the coating can be dragged on both plates. It has also

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been used extensively for both vertical and overhead fillets, especially where large single pass fillets are desired.

The ease of complete slag removal on square edge butt welds makes "Fleetweld 47" exceptionally excellent for this type of joint. Complete penetration of $^1/_4$" plate can be obtained by welding one pass from each side.

This new electrode is available in the following sizes: $^5/_{32}$" × 14"; $^3/_{16}$" × 14"; $^1/_4$" × 18" and $^5/_{16}$" × 18". The electrodes are packed in 50 pound containers.

This latest addition to the popular "Fleetweld" line of Lincoln electrodes has undergone extensive field tests with excellent results. Suitable for welding a wide variety of joints in all positions, "Fleetweld 47" produces smooth, uniform beads as shown in the accompanying photo of weld specimens.

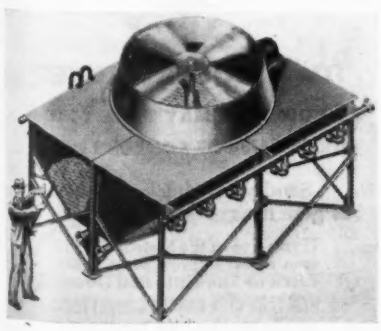
Head Stock Spindle for Turning Bolts

A head stock spindle, designed and developed at General Electric's Pittsfield Works, is particularly suitable for turning large bolts of the body-bound type. Through its use, both in and out of the lathe, handling time has been reduced 50 per cent.

Both ends of the bolts are centered, and when they are placed in the lathe a drive force is obtained by contact with two $^3/_8$–16 setscrews. Regardless of how the bolts are turned, it is necessary to center both ends for grinding purposes, thus, there is no additional expense. Since this new method eliminates the slow, conventional method of holding the bolts in a chuck, production is increased.

Alco Air Cooled Heat Exchanger

The Alco Air Cooled Heat Exchanger (illustrated) made by American Locomotive Co., 30 Church St., New York, N. Y. is used for cooling or condensing applications, as for instance, jacket water or lubricating oil cooling; steam condensing; gas cooling or vapor condensing. It uses air as a cooling medium, is unaffected by high humidity, and can be erected on top of existing structures if need be.



This exchanger can be used to particular advantage wherever there is insufficient water supply; scale from bad or brackish

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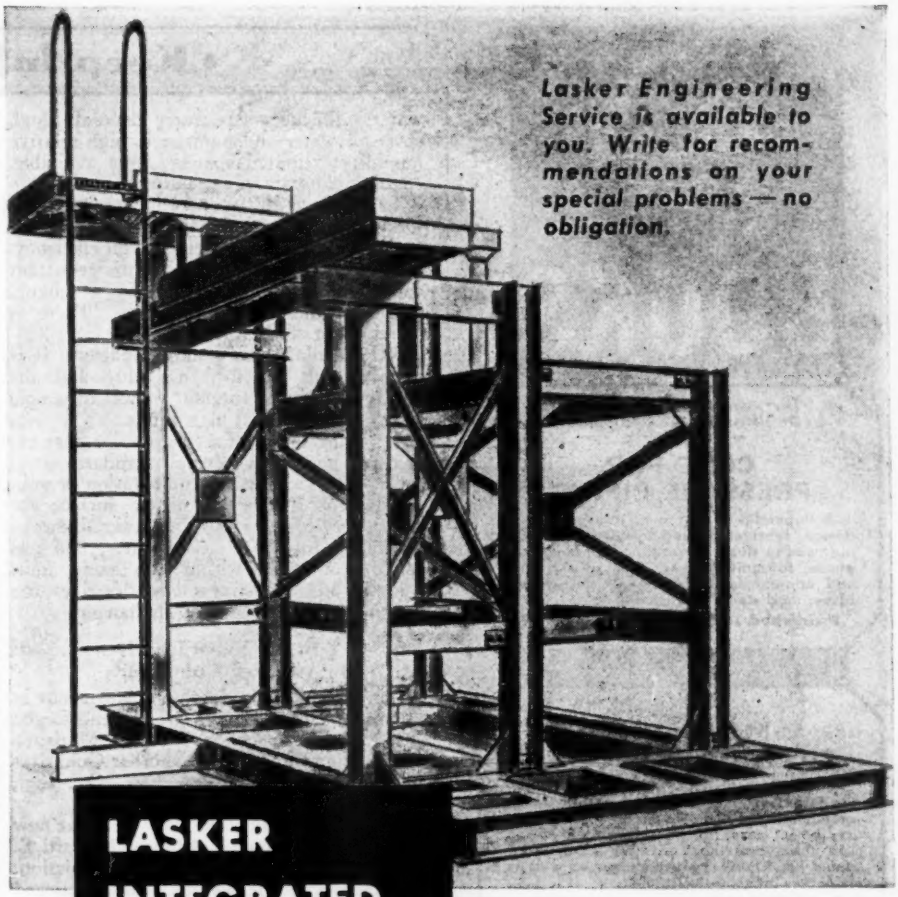

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MANUAL ON CUTTING OF METALS

A 320-page book for shop men, presenting tested data in tabular form from which speeds and feeds for metals in common use can be set for various depths of cuts. Time and horsepower necessary for a cut under stated conditions are also shown, as well as examples in the use of the data.

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A standard guide for the construction, installation, inspection, maintenance, and operation of cranes, and derricks driven by steam engines, electric motors, or internal combustion engines to their runways, to simple hoists, to overhead electric hoists and their runways, to overhead air hoists, and to hand-powered derricks.

Published 1943 (B30.2) $1.50

SAFETY CODE FOR ELEVATORS

Designed to insure safety in the construction, inspection, maintenance, and operation of all types of elevators, dumbwaiters, and escalators. Detailed recommendations are given for hoistways and enclosures, guides, buffers, counterweights, car construction and safeties, cable and signal systems, speed control, etc.; also for qualification and training of operators.

1937 Publication with 1942 Supplement (A17.1) $1.25

ELEVATOR INSPECTORS' MANUAL

Shows how to make a thorough and satisfactory inspection of all equipment involved from brake action, switches, stopping devices, speed, counterweight safeties, to control and operating equipment, car capacity, emergency exits and release, lighting, hoistway, elevator ropes, and rope sockets.

Published 1937 (A17.2) 75¢

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Publication Sales Dept.
29 West 39th St., New York 18, N.Y.

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water; difficult waste water disposal; high costs for water and pumping; high relative humidity; limited cooling space available. Among its outstanding features are:

1. Induced draft operation assures uniform air distribution over the heat transfer surface, thereby achieving high efficiency.
2. Vertical air flow permits constant cooling or condensing regardless of changing wind direction or velocity. There is no recycling of hot air.
3. Installation is a simple matter. It is factory built for field assembly and the sturdy steel construction allows an ample safety factor against high winds.
4. Multiplicity of services—this heat exchanger comes in several standard sizes, each of which allows a combination or subdivision of the heat transfer surface for many services, for instance, simultaneous cooling of lube oil, jacket water, and gas can be obtained within the same unit.

Bulletin 1035 illustrates and describes the new Alco Air Cooled Heat Exchanger.

Edward Valve Receives Another Gold Star

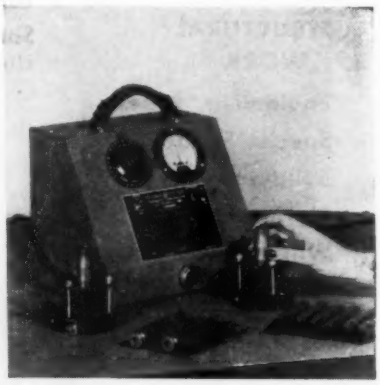
For continued production achievement in the manufacture of essential cast and forged steel valves, the United States Maritime Commission has awarded another Gold Star to The Edwards Valve & Mfg. Co., Inc., East Chicago, Indiana.

The Edward Maritime "M" pennant now flies five Gold Stars. Admiral Howard L. Vickery of the U. S. Maritime Commission, in announcing the award, also announced that the production award program of the Commission was discontinued as of March 31, 1945. In all, less than 200 "M" pennants were awarded to shipyards and key manufacturing plants.

Along with the additional Gold Star, the Edward plant will receive Maritime Labor Merit badges for all employees who have joined the Company since the last Gold Star was presented.

Redesigned Magnetic Comparator Announced by General Electric

The General Electric magnetic omparator, which provides a quick, simple, nondestructive method of inspecting ferrous parts for quality control, has been redesigned to permit a more functional arrangement of its components, according to an announcement by the Company's Special Products Division. Desirable for testing rods, bolts, springs, and small fabricated parts, this portable equipment immediately discerns variations in composition, hardness, or other characteristics which affect magnetic properties.



Features of the redesigned comparator include an attractive new grey steel case with a sloping front panel on which are located the indicating instrument, variable-voltage transformer, and the necessary rheostates and switches. Graduated dial plates on the sensitivity and balance control rheostats have been added to allow duplication of settings. In addition, a light now indicates whether or not the power is on. Receptacles for making connections to the test fixtures and power source are now located at the back of the case, thus keeping wires out of the operator's way and allowing a clear view of the indicating instrument.

The redesigned instrument incorporates all the basic functions of the previous model. The circuit is balanced by placing an acceptable part in each of the two test fixtures. One of these parts is then removed and those to be tested are individually inserted. Any deflection of the instrument pointer indicates a deviation in magnetic characteristics from that of the standard.

Homestead Valve Wins Fourth Gold Star

Admiral H. L. Vickery, Chairman of the U. S. Maritime Commission Board of Awards, has just advised Homestead Valve Manufacturing Co., Coraopolis, Pa., that the board, in recognition of continued production achievement, has awarded the Company its Fourth Gold Star to be added to its "M" Pennant, and badges of production merit for all employees added to the rolls since the last award.

In his letter to W. R. Schuchman, President of the Company, Admiral Vickery said, "In bringing to a conclusion the issuance of gold star awards as of March 31, 1945, you will please accept my sincere appreciation for your Company's continuing

CANCER KILLS 1 ADULT OUT OF 6—IT MAY KILL YOU!

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YOUR GIFT MAY SAVE YOU OR THE LIFE OF SOMEONE DEAR

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as generous as you can make it.

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130 East 66th Street, New York 21, N.Y.

AMERICAN CANCER SOCIETY
350 Fifth Avenue, New York 1, N.Y.

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contribution to merchant ship construction, and extend to all of your employees my warmest congratulations for the attainment of high goals in support of the valiant men of our Army, Navy and Merchant Marine".

Zurn AwardedArmy-Navy "E"

The much coveted Army-Navy "E" Flag was awarded to the J. A. Zurn Mfg. Co., Erie, Pa., Ordnance Division, at a recent colorful ceremony.

Presentation of the flag was made by Lt. Col. Harry P. Croft, Chief Industrial Division, Army Service Forces, Cleveland Ordnance District, to Everett F. Zurn, Secretary-Treasurer of the company. Lt. Comdr. R. C. Greenwald, U.S.N., then presented the "E" lapel pins to Melvin A. Zurn, President. Mrs. L. H. Starks and John J. Kozak accepted the pennant and pins in behalf of all the employees of J. A. Zurn Mfg. Co.

Appreciation was expressed in the souvenir program to the Armed Service Forces' personnel on furlough who have contributed greatly to the production record; also to John W. Moran, Cleveland District Representative and his staff who have rigidly maintained a high standard of inspection.

Dr. Charles Reitell of Columbia University acted as chairman of the proceedings.

Electronic Controls Speed Aluminum Skin for Fighting Planes

Electronically controlled production of aluminum sheets or "skins" for bomber, fighter and other war aircraft wings and fuselages has passed its initial test successfully, it was revealed by L. Morton Morley, vice president and general sales manager of the Brown Instrument Co., Philadelphia.

Experience with this new control principle has resulted, Mr. Morley stated, in increased production of aluminum and planes and, through better quality aluminum, in improved plane performance.

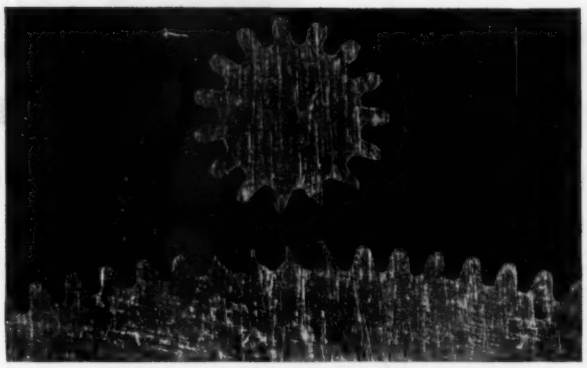
One of the first and largest precision instrument control installations, Mr. Morley said, is at the McCook, Ill. plant of the Aluminum Company of America where more than 400 recording and control instruments have been installed by the Brown organization, a division of Minneapolis-Honeywell Regulator Company. The McCook plant, he added, was placed in operation about a year ago for production of aluminum sheets for war planes.

"Continuous balance electronic potentiometers have played a new and unique role in Alcoa's aluminum rolling mill operation," said Mr. Morley. "While the majority of the instruments at the McCook plant are used for conventional applications," he continued, "the electronic instruments, the principle of which was first introduced in flight test recorders, are used for measuring and close control of specific temperatures.

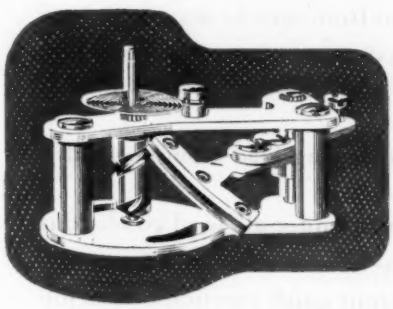
"The electronic industrial control instruments are being used at the McCook Alcoa plant for measuring temperature of aluminum ingots, slabs and sheets. The instruments are installed at three different processing points,

Continued on Page 38

HOW ARE YOUR TEETH WEARING?



Here's what happened to the stainless steel gear teeth of a good conventional gauge movement after 500,000 cycles of operation at 1200 pressure pulsations per minute. In contrast — after 30,000,000 cycles, the cam facing of the *Helicoid movement* was merely burnished, and the accuracy of the Certified Gauge was unaffected. This was the result of a test made by an independent laboratory.



Only Certified Gauges are made with the Helicoid movement. This means there are no teeth to wear out or get sticky. The smooth rolling action of the Bakelite cam against the hard bronze roller practically eliminates wear.

HAVE you looked at the gear teeth in your pressure gauges lately? Are they so worn that your gauges are inaccurate and unreliable? If so, better replace with Certified Gauges to eliminate gear teeth trouble.

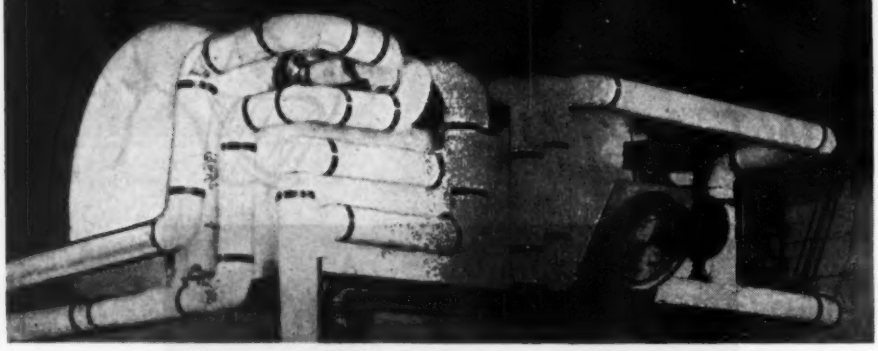
All Certified Gauges are guaranteed accurate to within ½ of 1%. They stay accurate longer. They are ideal for pumps, compressors, presses, turbines, etc. Send for catalog.

Certified GAUGE AND INSTRUMENT CORP.

[illegible] Long Island City 1, New York

5-EG-3

This STEAM DRUM *is an* UNFIRED *pressure vessel*



IN THE International-LaMont Forced Recirculation Boiler, Type LFS, the steam drum is not exposed to the fire or heated gases. No steam generating tubes are expanded into the drum. Therefore it can be located below the top of the boiler structure or supported on the wall of the boiler room, where the headroom is limited for connections to the main steam header.

Other distinctive Type LFS advantages are:

The boiler is in full circulation from zero to maximum load.

Higher efficiencies due to maximum radiant heat absorbing surface in furnace water-walls and effective arrangement of secondary heating surfaces.

Extreme flexibility—follows swinging load from no load to maximum load instantaneously.

Steady water line and dry steam under all load conditions.

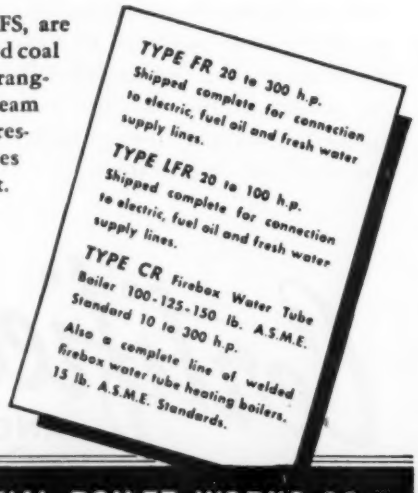
Minimum space requirements—low headroom a feature.

Shop tested sub-assemblies permit quick erection on the job.

International-LaMont Boilers,* Type LFS, are designed for firing with oil, gas, pulverized coal or stokers. They are available in sizes ranging from 4,000 to 30,000 pounds of steam per hour and in all standard working pressures. Larger sizes and special pressures or superheat requirements on request.

Write today for bulletin illustrating and describing special features of this Type LFS Boiler.

*Licensed under LaMont patents.


TYPE FR 20 to 300 h.p.
Shipped complete for connection to electric, fuel oil and fresh water supply lines.
TYPE LFR 20 to 100 h.p.
Shipped complete for connection to electric, fuel oil and fresh water supply lines.
TYPE CR Firebox Water Tube Boiler 100-125-150 lb. A.S.M.E. Standard 10 to 300 h.p.
Also a complete line of welded firebox water tube heating boilers. 15 lb. A.S.M.E. Standards.

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POWER DIVISION
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for in each of the three operations temperature must be taken at extremely high speed.

"Electronic instruments, unlike prewar mechanically operated measuring and control devices, were found to be unaffected by vibrational disturbances, even when installed in the immediate vicinity of traveling cranes that transported huge aluminum ingots from soaking pits. It was also found unnecessary to provide special shockproof or vibration absorbing equipment for the new electronic controls."

• BUSINESS CHANGES

O'Connor Elected Vice President

William T. O'Connor has been elected Vice President in Charge of Purchases of Manning, Maxwell & Moore, Inc., by the Board of Directors at their annual meeting.

Mr. O'Connor came with Manning, Maxwell & Moore, Inc., as Purchasing Agent in 1928 when the Company acquired The American Schaeffer & Budenberg Co. with whom he had the position of Purchasing Agent.

The company has plants at Boston, Massachusetts; Bridgeport, Connecticut; Muskegon, Michigan; Tulsa, Oklahoma, and Jersey City, New Jersey.

Heppenstall, Jr., now Vice President

H. K. Porter Co., Inc. announces the election of S. B. Heppenstall, Jr., as Vice President. He will make his headquarters in the general offices of the Porter Co. in Pittsburgh.

Mr. Heppenstall was formerly Vice President in Charge of Sales of the Heppenstall Co. He is a member of the Association of Iron and Steel Engineers and the American Iron and Steel Institute.

New Distributor for Gerotor May

Gerotor May Corp., Logansport, Ind., announces the appointment of Compressed Air Products, Newark, N. J. as exclusive sales representative of Gerotor air and hydraulic devices for New Jersey and Greater New York.

Headed by Addison T. Smith and Walter R. Ellis, the organization of Compressed Air Products has had long experience in the air and hydraulic field.

The line of Gerotor air and hydraulic products handled by Compressed Air Products includes valves, cylinders, pumps, fluid motors, pump units, work-holding devices, presses and vices.

Mack Sales, Distributor for Florida

The Briggs Clarifier Co., Washington, D. C., Manufacturers of Industrial, Marine and Automotive oil filtration equipment has just announced the appointment of Mack Sales, 425 East Platt Street, Tampa, as Distributor for the State of Florida.

F. F. Mack, who heads the firm, has ably contributed to the war effort during the past

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few years by concentrating his talents on the production of vitally necessary torpedoes.

When his war work was completed recently, he was eager to return to active sales work. Mr. Mack has organized his company to give prompt and efficient service to all present and future Briggs customers in the State of Florida.

Ohmite Gift

Chicago, Ill.—Dr. Henry T. Heald, president of Illinois Institute of Technology, announces an initial grant of $15,000 from the Ohmite Manufacturing Co. to be used for the establishment of a laboratory for the precision measurement of electrical and magnetic quantities.

The gift, came through David T. Siegel, president of Ohmite Manufacturing Co. and a trustee of Illinois Tech. It represents the initial contribution for equipping what will be known as the Ohmite Laboratory for Precision Measurements. It will be constantly expanded as new equipment becomes available.

The laboratory's ultimate goal is to provide precision electrical measurements for the Chicago area approaching in accuracy those of the Bureau of Standards in Washington, D.C.

Working through the Armour Research Foundation, industries in the vicinity will have an opportunity to use the laboratory's facilities. This will be the first such laboratory in the Chicago area to make its services available to industry. As such, the establishment of this laboratory is a definite contribution to the scientific and research facilities of the area.

In addition, the laboratory represents an important addition to Illinois Tech's electrical engineering equipment, by means of which graduate students can be trained in precision electrical measurements. It will further provide standards for research work carried on at the Foundation.

The laboratory itself will be located at the Armour Research Foundation of Illinois Institute of Technology and will be developed under the direction of Prof. E. H. Schulz, supervisor of electrical engineering laboratories, and L. W. Matsch, supervisor of electrical engineering in the Armour Research Foundation. Also on the committee supervising the laboratory's construction are Dr. H. A. Leedy, Dr. W. A. Lewis, Dr. Thomas C. Poulter, Raymond E. Zenner and Dr. James S. Thompson.

Space has already been reserved for the laboratory in the engineering building of the Research Foundation and equipment will be placed in operation as soon as it can be obtained under present wartime conditions. It is hoped that the basic elements will be operating within six months, although some of the needed equipment cannot be obtained until after the war.

Mr. Siegel, in presenting the gift, stated the purpose of the laboratory as follows:

1. To provide facilities for studying the fundamental measurement of resistance, inductance, capacitance, current, voltage, power, power factor, permeability, etc.,—basic quantities of electric and magnetic circuits and fields.

2. To provide calibration facilities for instruments and meters used in research and industry by affiliated organizations at Technology Center and by industries of the Chicago area.

3. To stimulate advanced training of the electrical engineering students at the Illinois Institute of Technology in the important field of precision measurements.

Continued on Page 40

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Design, construction and installation of complete plants and projects

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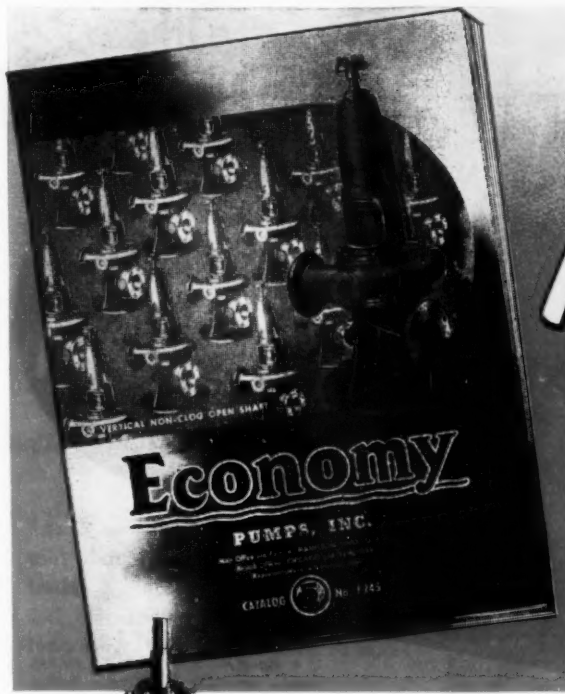
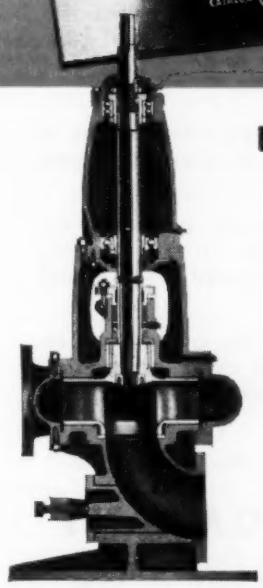


Ask for Your Copy



Cross Section view of Type SSV Pump showing Adjusting Nut for taking up Impeller wear, Bronze Renewable Shock Absorber and other exclusive features described in Cat. F-245.

Featuring the Newest Designs... Complete Selection Tables of VERTICAL NON-CLOG PUMPS!

Here's your answer to the problem of pumping liquids containing solids, etc. Catalog F-245 fresh off the press presents the last word in Non-Clog construction—backed by over 30 years specialized experience, precision manufacture and modern production practice. Selection tables simplify the choice of exact types and sizes to handle your requirements. A copy of the Catalog is yours for the asking. So are the services of our engineering staff.

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CONTROL OF TEMPERATURE IN LIQUIDS and GASES

HELPS INCREASE PRODUCTION

U. S. Patent Nos. 2,296,940 and 2,321,933. Re-Issue No. 22,553—Other Patents Pending.

● During the first year of the war, hundreds of installations of the NIAGARA AERO HEAT EXCHANGER were made to assist in war production in various industries.

Many of these installations, which were made primarily because they offered the advantage of saving the cost of cooling water, now show an extra value of great importance in increasing plant production.

Production is increased in three ways: (1) By preventing rejections (2) By permitting quicker starting of every production batch at the correct temperature (3) Your production is faster, due to your *constant* temperature.

Write for illustrated Bulletin No. 96.

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HUMIDIFYING • AIR ENGINEERING EQUIPMENT

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In further commenting on the value of the laboratory, Dr. Jesse E. Hobson, director of the Armour Research Foundation, said, "In all electrical work careful measurement of the quantities used is essential. The Bureau of Standards in Washington maintains the most accurate standards. For convenience, however, it is highly desirable to have throughout the country intermediate standards almost as accurate as those in Washington and more precise than the usual commercial measurements. Our function here is to provide one of those intermediate stations."

Power companies, manufacturers of various kinds of electrical equipment, and colleges are among the organizations which will immediately benefit from the project.

AE Appoints Stoker Agents

American Engineering Co., Philadelphia, announces the appointment of three additional sales agents.

Milton G. Brown, 1847 East 28th St., Minneapolis 7, Minn. will represent the Taylor Multiple Retort and AE Perfect Spread Stokers in Minnesota, North Dakota and South Dakota, and the AE Perfect Perfect Stoker in the northwestern section of Wisconsin.

J. J. O'Shea, 305 Techwood Drive, N.W., Atlanta, Georgia will represent both Taylor Multiple Retort and AE Perfect Spread Stokers in Alabama, Florida, Georgia and South Carolina.

Thomas C. Messplay, 5916 McGee St., Kansas City, Mo., will represent both stokers in the states of Kansas, Oklahoma and the western section of Missouri.

Lunkenheimer Elects

At the annual meeting of The Lunkenheimer Co., Cincinnati, held recently, the following officers and directors were elected: Frank P. Rhame, President and General Manager; Homer E. Lunken, First Vice-President and Assistant General Manager; Harry A. Burdorf, Vice-President, Sales; Charles W. Burrage, Secretary; Chester C. Isekeit, Treasurer and Controller. Directors are Harry A. Burdorf, Henry G. Frost, Chester C. Isekeit, Carl M. Jacobs, Edmund P. Lunken, Homer E. Lunken, Frank P. Rhame.

Wickwire Spencer Announces New England Traffic Division Changes

The location and mailing address of the New England Traffic Division, Wickwire Spencer Steel Co. has been changed from 80 Webster Street to New Bond Street, Worcester 6, Mass., it was announced recently by Harry M. Marsales, General Traffic Manager.

Also announced was the promotion of Joseph S. Sampson to the position of Assistant to the General Traffic Manager. Mr. Sampson formerly headed the New England Traffic Division.

Donald J. Carey has been appointed Division Traffic Manager in charge of the New England Division.

Leister to Head Fafnir Engineering

Fayette (Cy) Leister has been advanced to the position of Engineering Manager of The Fafnir Bearing Co., New Britain, Conn.

Popularly known as "Cy" Leister, the head of Fafnir's Engineering Division is recognized as one of America's foremost engineers in the anti-friction bearing industry. He joined Fafnir in 1921 as a sales engineer. His valuable contributions to the betterment of ball bearing manufacture and application resulted in his subsequent appointment as assistant works manager.

• Keep Informed

For the past 10 years Mr. Leister has been manager of the important Detroit territory and has been called upon for engineering aid in a wide Midwestern area. His bearing application knowledge has been sought by many of the nation's largest manufacturers in the design of new products.

As Engineering Manager, Mr. Leister will head up all phases of product design and development, quality standards, testing and research, engineering data and service engineering.

Foote Bros. Gear Changes Pittsburgh Address

Foote Bros. Gear & Machine Corp., Chicago, Ill., announces a change in address of their Pittsburgh sales representative, the W. G. Kerr Co., effective April 20th. The new location is 520 Oliver Building, Pittsburgh 22, Pennsylvania. William G. Kerr and Robert J. Beler are principles of the Kerr Company representing Foote Bros. speed reducers and industrial gears in Western Pennsylvania.

Farrel-Birmingham Elects New Officers

At the annual meeting of the Board of Directors of Farrel-Birmingham Co., Inc., held at Ansonia, Conn., recently, Franklin Farrel, Jr., resigned as chairman of the Board of Directors, and Alton Austin Cheney of Plandome, New York was elected to succeed him.

Franklin Farrel, Jr. is the grandson of Almon Farrel, and the son of Franklin Farrel, Sr., founders of Farrel Foundry & Machine Co., which was started in Ansonia in 1848. Mr. Farrel has been affiliated with the company in various capacities since 1903 and has served on the Board of Directors since 1904. He will continue as a director and as Chairman of the Finance Committee.

Alton Austin Cheney, the new board chairman, is also a direct descendant of the company's founders, being a great grandson of Franklin Farrel, Sr. He has been a director of Farrel-Birmingham since 1931.

Lester D. Chirgwin, General Manager of the company's Buffalo plant, was elected Vice President in charge of manufacturing, and Franklin Farrel, 3rd, Plant Manager, Ansonia-Derby plants, was elected Secretary and Assistant Treasurer. Other officers re-elected were Franklin R. Hoadley, President; Carl Hitchcock, Armin G. Kessler and Austin Kuhns, Vice Presidents; and Frederick M. Drew, Jr., Treasurer and Assistant Secretary.

Carl F. Schnuck, Chief Engineer of the company, and William M. Fraser, General Manager of The Atwood Machine Co., Stonington, Conn., recently acquired by Farrel-Birmingham, were elected directors.

Farrel-Birmingham Appoints Export Sales Manager

Farrel-Birmingham Co., Inc. of Ansonia, Conn. and Buffalo, New York, announces the appointment of Eric C. Gyllensvard as export sales manager, with office at 3700 Chrysler Building, New York, N. Y.

Mr. Gyllensvard comes to this new post with a broad and extensive experience in the export sales field. Born in Sweden and of Swedish descent, he was educated in England where he graduated from Cambridge University, receiving his BA degree in mechanical engineering in 1927. While at Cambridge he also specialized in economics. After graduating Mr. Gyllensvard joined the Standard Oil Company and spent the following eight

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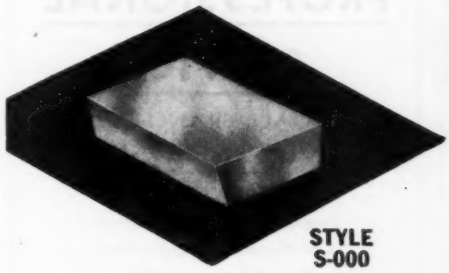
New

KENNAMETAL

"Universal"

BLANKS



STYLE S-000

FACILITATE TOOL MAKING

and Keep Stocks Down

These new Kennametal "Universal" tool blanks are literally "jacks-of-all-trades." Rectangular in shape, with 12° clearance angle formed on one long edge, they can be used to make many different types of tools, simply by setting them into open-end recesses, as illustrated. They are available in all recognized standard sizes, many of which are stocked in several grades.

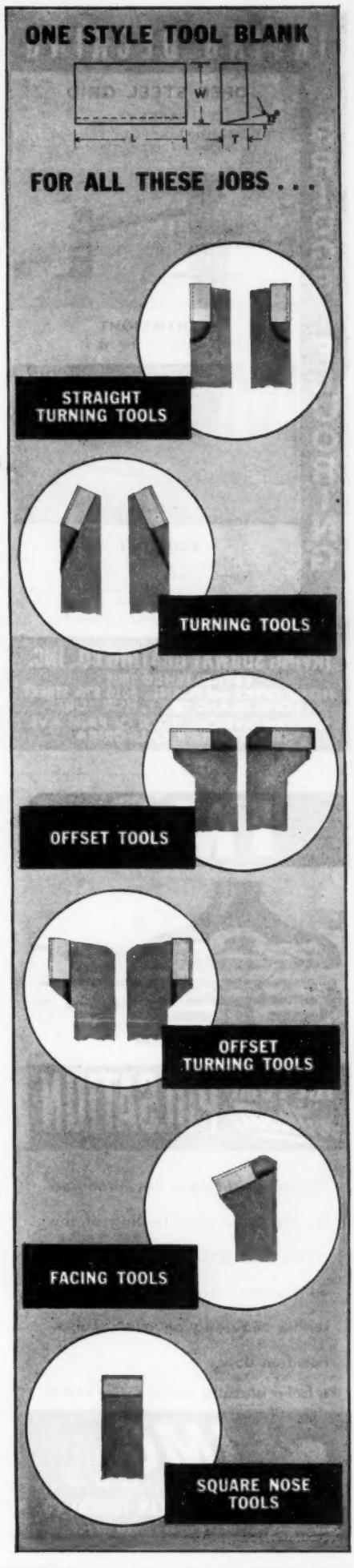
Their use reduces inventory investment, and simplifies stock room problems. And, above all, they make it easier for you to employ on a widespread, yet economical scale, the advantages of Kennametal — its ability to cut metal, including steel up to 550 Brinell hardness, accurately, at greatly increased speed, with amazing tool life.

Catalog particulars, and prices, are yours for the asking.

KENNAMETAL

SUPERIOR CEMENTED CARBIDES

KENNAMETAL Inc., LATROBE, PA.



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OPEN STEEL GRID
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Permanent Inwrought Traction
Self-Cleaning Surface

LIGHTWEIGHT
Only 15¼ lbs. per sq. ft.

ECONOMY
Minimum Maintenance
Non-Erasible Lane Markers
Restores Old Bridges
Reduces Cost of New Bridges
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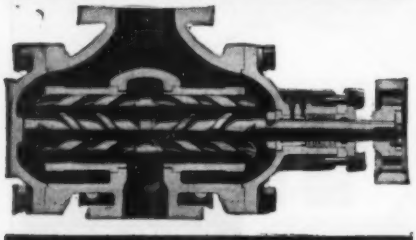
IMO



THE PUMP *without* PULSATION

The steady, uniform flow produced by the continuous turning of the rotors in an IMO pump is ideal for oil burners, hydraulic and other service requiring an even, pulsation-free flow.

For further information send for Catalog I-120-M.

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PUMP DIVISION OF THE
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TRENTON 2, NEW JERSEY

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years, first as petroleum engineer, and later as sales engineer in the service of this company's subsidiaries abroad. He worked in Peru, Argentina and Brazil in South America, and in India, Malay, Dutch East Indies, Phillippines and China in the Far East.

In 1937 Mr. Gyllensvard left the Standard Oil Co. and joined Sullivan Machinery Co. of Michigan City, Indiana and Claremont, New Hampshire, as export manager with offices in New York, N. Y. He has handled this company's extensive export operations for the last seven years.

In 1942 he was elected president of the Machinery and Metals Export Association, which is composed of export managers of leading industrial machinery and steel concerns. He was re-elected president for a second term in 1943. Following our entry into the war Mr. Gyllensvard has also served in an advisory capacity on various government committees in Washington, handling export controls. He served in 1942 and 1943 on the Lend-Lease Foreign Trade Council, appointed by Mr. E. R. Stettinius, Jr., and is now serving on the Foreign Economic Administration Advisory Committee. He is also a member of the Far Eastern Committee of the National Foreign Trade Council.

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• LATEST CATALOGS

Heavy Steel and Alloy Forgings

An interesting new 8-page bulletin has just been published by the Titusville Forge Division of Struthers Wells Corp. describing the company's facilities for precision forgings regardless of size, metal or alloy.

Illustrated are many outstanding forgings recently produced, including a description of Titusville's research, engineering and plant facilities. The company has forge presses from 500 tons to 2000 tons capacity, 172 welding machines in its two large welding shops, three large modern machine and pattern shops, a large number of 60-foot lathe of 80° swing, boring lathe up to 108 feet in length, as well as modern vertical and horizontal heating furnaces, oil and water quenching tanks and other unexcelled equipment.

Copies of this new bulletin "Titusville Heavy Steel and Alloy Forgings" may be secured through this publication or by writing direct to Titusville Forge Division, Struthers Wells Corp., Titusville, Pa.

Valve Lubrication and Maintenance

An instructive manual designed to guide users of Nordstrom Valves in the proper methods and routine of lubricating plug valves has been issued by Merco Nordstrom Valve Co. The bulletin illustrates each type of valve, revealing the operation and gives plain, specific directions how to lubricate, when, and the type of lubricant best suited for specific services. Twenty-four groups of valve parts are illustrated so that the user may select replacements. Grease gun lubrication is also discussed. The bulletin will serve as a convenient reference for servicemen, plant operators and others responsible for efficient valve operation. A copy of the bulletin, V-126, may be obtained from Merco Nordstrom Valve Co., 400 N. Lexington Avenue, Pittsburgh 8, Pa.

New Catalog Issued by Nordstrom

A completely new, revised catalog has just been issued by Merco Nordstrom Valve Co. It makes obsolete all previous editions of Nordstrom Valve catalogs and valve bulletins. Comprised of 134 pages of valve listings and specifications, engineering tables, lubricant data, etc., it presents the latest information regarding the entire line of Nordstrom Valves.

Numerous revisions were made in the specification tables. Certain sizes and types, which previously overlapped other sizes, have been eliminated so that the new catalog presents a more streamlined arrangement of valves in keeping with the government's desire to avoid duplication of products and to provide greater simplification of cataloging.

Keep Informed

Many new and useful engineering tables have been added. Parts for the various types of valves are illustrated; also detailed drawings clearly depicting the features of construction. The latest listing of Nordco lubricants includes several new numbers.

A copy of the catalog, No. 9, may be obtained by valve users from Merco Nordstrom Valve Co., 400 N. Lexington Avenue, Pittsburgh 8, Pa.

Struthers Wells Announces New Tangent Bender Bulletin

A new 16-page bulletin, pictorially describing in detail many of the suggested products that can be produced on the improved Tangent Benders, has just been released by Struthers Wells Corp., Titusville, Pa.

The bulletin provides comprehensive data on the Single Wing, Double Wing and the newly developed Stretch Wing Tangent Bender Machines, with important engineering information, special features, product shapes and designs that can be formed in a single operation.

The manufacturer states this bulletin is a "must" for design engineers and those associated with metal products, because so many new uses for the varied metal working industries have been discovered and rapidly developed since the introduction of hydraulic Tangent Benders about a year ago. It is estimated, by the orders already placed for these machines, that approximately 90 per cent of all post-war refrigeration cabinets will be produced by this method.

Truck bodies, radiator covers, metal desks, chairs, cabinets, tables, complete kitchens and bathrooms, freezer cabinets, washing machines, laundry trays, radiant heaters, fluorescent lighting fixtures and many other common products that can be formed on Tangent Benders are shown in the bulletin.

While Tangent Benders were originally designed for the edge bending of metal sheets, the efficient bending of large and small parts is now possible through further improvements in design. Entirely silent and automatic, the machines are so quick in operation that work is formed as fast as a workman can place the metal sheets.

One outstanding feature on all Struthers Wells Tangent Benders is the patented rocker plate which maintains a constant, uniform, tangential pressure and alignment during the bending operation. The bulletin explains how this feature is responsible for the ability of the machine to economically and easily edge bend sheet metal, an operation which has heretofore been so expensive that it could not be adapted economically to manufacturing operations.

Another feature of the Struthers Wells Machines is the expanding die, which automatically provides for the commercial variations in the thickness of metal sheets, thus eliminating the necessity of gauging, separating, then running through the former non-expanding shimmed dies to compensate for the differences. After many thousands of operations, this die still maintains its minute accuracy to conform to the closest tolerances.

Copies of the new bulletin may be secured through this publication or by writing to W. T. Davidson, Research Director, Struthers Wells Corp., Titusville, Pa.

Westinghouse Steam Power Plant Planning Guide Announced

Planning information on 10,000 to 60,000 kw. condensing turbines, surface condensers and auxiliaries, for building a new plant or adding generator capacity to an existing one, is presented in the new Steam Power

Continued on Page 44

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• Keep Informed . . .

Plant Planning Guide announced by Westinghouse Electric & Manufacturing Co.

Part I of the new 40-page booklet illustrates types of turbines, and charts turbine sizes and speeds. Part 2 on Performance Data covers basic operating conditions, including effect of deviation in pressures and temperatures on heat rates; regenerative feed-water heating; recommended condenser sizes, and condenser dimensions; condenser friction; impeller, propeller and axial type circulating pumps; and condensate pumps. Data is presented in chart and table form for easy selection.

Copies of the new booklet (B-3153) may be secured from P. O. Box 868, Westinghouse Electric & Manufacturing Co., Pittsburgh 30, Pennsylvania.

Useful Data on Gears

Illinois Gear & Machine Co., 2108 N. Natchez St., Chicago (35) Ill., 64-page illustrated Catalog No. 39 lists available gears and contains technical information for ordering gears correctly, symbols used in designating gear parts, formulas for computing horsepower of various gears, factors for determining strength of gear teeth and many other handy calculations. Shows facilities for production of bevel, spiral, internal, spur and other gears.

Glossary of Forging Terms

Kropp Forge Co., 5301 W. Roosevelt Road, Chicago (50) Ill., 20-page illustrated booklet presenting alphabetically the definitions of forging terms to aid buyers and users of forgings. All words and terms are defined as used in present day forging practice.

Split Gland Inclined Water Gages

Ernst Water Column & Gage Co. now has available an 8-page Bulletin "C," covering adjustable "Split Gland" Inclined Water Gages, made of Bronze and Forged Steel construction, for pressures up to 900# P.S.I.

This is very handy to have, as it also illustrates the Adjustable Gages, set in a vertical position. This Bulletin "C" may be obtained by writing Ernst Water Column & Gage Co., 250 South Livingston Ave., Livingston, N. J., or by telephoning Livingston 6-0276.

Non-Magnetic Applications for Amsco Manganese Steel

American Manganese Steel Division of American Brake Shoe Co., Chicago Heights, Ill., Bulletin No. 1144-N, 32 pages, presenting and illustrating applications where the qualities of impact resistance and/or abrasion resistance are a requisite for certain equipment parts also requiring non-magnetism, which is likewise present in austenitic manganese steel.

Positive Displacement Blowers Explained

The principle of operation and the design and construction features of Pottstown rotary positive displacement type blowers and exhausters are pictured and described in a new 16-page bulletin issued by Allen Billmyre Co.

This type of unit is designed for services where volume of air or gas discharged must remain constant under variations in pressure or vacuum. Such services include agitation of liquids, air blast cleaning, pneumatic conveying, sewage disposal, vacuum cleaning, blacksmith forges, gas and oil burners, among many other uses.

The bulletin is profusely illustrated with sectional drawings and views of parts showing the design and construction of these units, also photographs of the many types of drive and arrangement which are available. Also included in the bulletin are tables of capacity for both blowers and exhausters, and technical data which will be found helpful in the selection of a suitable unit for a desired service.

Copies of this informative bulletin—No. P100—are obtainable on request to Pottstown Blower Co., Division of Allen Billmyre Co., 431 Fayette Avenue, Mamaroneck, N. Y.

Bronze Casting Alloys

A 48-page Reference Book on Bronze Casting Alloys has just been published by American Manganese Bronze Co., Philadelphia, Pa. In it is given general information regarding composition, characteristics and applications of many of the common or typical alloys. The book will help the engineer or designer in the selection of the right alloys for any general application.

New Catalog on Airblast Equipment

A new illustrated catalog has just been published by American Foundry Equipment Co., 555 South Byrkit Street, Mishawaka, Indiana, describing its complete line of Airblast equipment, which includes Rooms, Cabinets, Tanks, Suction Guns, Nozzles, and Accessories.

A copy of this catalog can be obtained by writing direct to the manufacturers or its district sales representatives.

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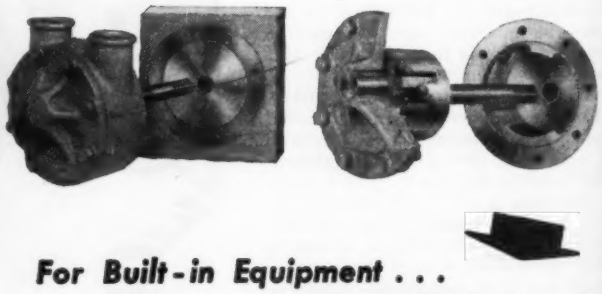

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